



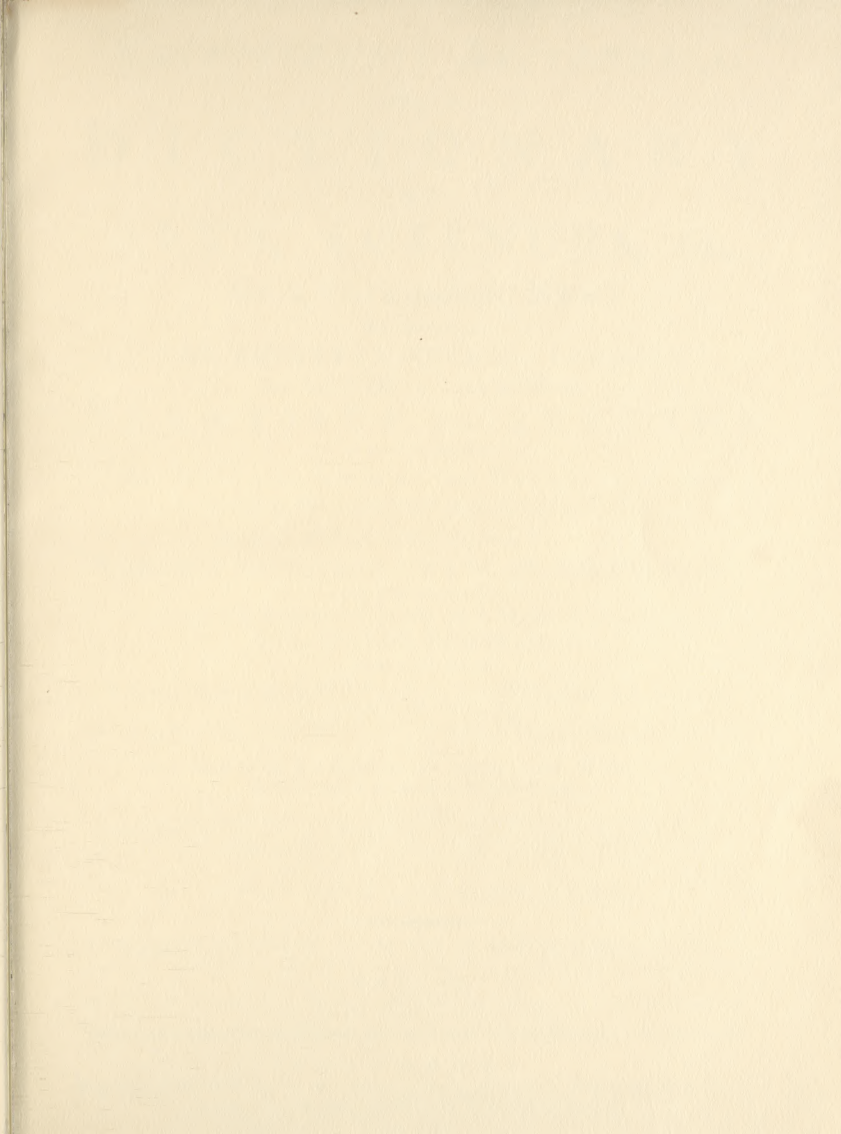
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V O L. VII.

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INDOCTI DISCANT, ET AMENŒ MEMINISSE PERIT.

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MDCCLXXXI.

ENCYCLOPEDIA BRITANNICA  
D I C T I O N A R Y  
ARTS & SCIENCES

On a Plain copy New

By W. G. S. ...

THE DIFFERENT SYSTEMS AND ARTS

As they are now practised

THE ARTS OF ...

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THE HISTORY OF THE ARTS AND SCIENCES

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VARIOUS PARTS OF KNOWLEDGE

NATURAL AND ARTIFICIAL

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## Dictionary of Arts, Sciences, &amp;c.

## M E D

Medicines,  
Medietas.

**M**EDICINES, whatever substances serve to restore health.—Medicines are either *simple* or *compound*; the former being prepared by nature alone; and the latter owing to the industry of man, by variously mixing the simple together. See PHARMACY.

MEDICINES are likewise distinguished, from the manner of using them, into *external* and *internal*; and with regard to their effects, they are said to be *emetic*, *cathartic*, *astringent*, &c. See MATERIA MEDICA.

*Pocket* MEDICINES, in surgery, those which a surgeon ought always to carry about with him, in a box, or convenient case.

Those, according to Heister, are the common digestive ointment, and the brown or Egyptian ointment, for cleansing and digesting foul ulcers; and some vulnerary balsams, as the *linimentum Arcaei*, or the balsam of Peru, Gilead, or Copivi, or the Samaritan balsam: to these must also be added a plaster or two; as the *diachylon* or *sypiticum Crolii*, since one or other of these is almost constantly wanted. Neither should there be wanting a piece of blue vitriol for the taking down luxuriant flesh, and to stop hæmorrhages: but if vitriol is wanting, burnt alum, red precipitate, the infernal stone, or any other corrosive medicine, will supply its place in corrosive intentions; and the last will also serve to open abscesses, to make issues, and perform many other operations of that kind.

With these there should always be kept in readiness also a quantity of seraped lint, that the surgeon may be able to give immediate assistance to wounded persons; since, if he is unprepared for this, they may easily be taken off by an hæmorrhage; a circumstance which ought also to prevail with him to be always provided with suitable bandages.

MEDIETAS LINGUÆ, in law, signifies a jury, or inquest impelled, of which the one half are natives of this land, and the other foreigners. This jury is never used except where one of the parties in a plea is a stranger, and the other a denizen. In petit-treason, murder, and felony, foreigners are allowed this privilege; but not in high-treason, because an alien in that case shall be tried according to the rules of the common law, and not by a *medietas lingue*. A grand jury ought not in any case to be of a *medietas lingue*; and the person that would have the advantage of a trial in this way, is to pray the same, otherwise it will

## M E D

Medimnus,  
Medina.

not be permitted on a challenge of the jurors.

MEDIMNUS, in Grecian antiquity, a measure of capacity. See MEASURE.

MEDINA-TALNARI, a famous town of Arabia Petræa, between Arabia Deserta and Arabia the Happy; celebrated for being the burial-place of Mahomet. It is seated in a plain abounding with palm-trees, in E. Long. 39. 53. N. Lat. 25. See (*History of*) ARABIA.

MEDINA-Celi, an ancient town of Spain, in Old Castile, and capital of a considerable duchy of the same name; seated near the river Xalon, in W. Long. 2. 9. N. Lat. 41. 15.

MEDINA-de-las-Torres, a very ancient town of Spain, in Extremadura, with an old castle, and the title of a duchy. It is seated on the confines of Andalusia, at the foot of a mountain near Bajadoz.

MEDINA-del-Campo, a large, rich, and ancient town of Spain, in the kingdom of Leon. The great square is very fine, and adorned with a superb fountain. It is a trading place, enjoys great privileges, and is seated in a country abounding with corn and wine. W. Long. 4. 20. N. Lat. 41. 22.

MEDINA-del-rio-Secco, an ancient and rich town of Spain, in the kingdom of Leon, with the title of a duchy; seated on a plain, where there are fine pastures. E. Long. 4. 33. N. Lat. 42. 8.

MEDINA (Sir John), an eminent painter, was the son of Medina de l'Asturias, a Spanish captain, who had settled at Brussels; where the son was born, and instructed in painting by Du Chatel. He married young; and in 1686 came into England, where he drew portraits for several years. The earl of Leven encouraged him to go to Scotland, and procured him a subscription of 500l. worth of business. He painted most of the Scotch nobility; and at Wentworth-castle is a large piece, containing the first duke of Argyle and his sons, the two late dukes John and Archibald, in Roman habits; the style Italian, and superior to most modern performers. The portraits of the professors in the surgeons-hall at Edinburgh were painted by him, and are commended; and in that hall are two small history-pieces by him. He was knighted by the duke of Queensberry, lord high-commissioner; and was the last knight made in Scotland before the Union. He was not, however, rich; for he had 20 children. He died in Scotland; and was buried in the church-

Medio-  
lanum  
||  
Medium.

yard of the Gray-friars at Edinburgh in 1711, aged 52. He was capable both of history and landscape. The prints in the octavo edition of Milton were designed by him.

**MEDIOLANUM**, an ancient city, the capital of the Insubres, built by the Gauls on their settlement in that part of Italy. A *municipium*, and a place of great strength. The seat of the liberal arts; whence it had the name of *Novæ Athene*. Now *Milan*, capital of the Milanese, situate on the rivers Olana and Lombro. E. Long. 9. 30. N. Lat. 45. 25.

**MEDIOLANUM Aulerorum** (anc. geogr.), a town of Gallia Celtica, which afterwards took the name of the *Ebuovicum Civitas* (Antonine); corrupted to *Civitas Ebroicorum*, and this last to *Ebroica*; whence the modern appellation *Evreux*, a city of Normandy. E. Long. 1. 12. N. Lat. 45. 21.

**MEDIOLANUM Gugernorum** (anc. geogr.), a town of Gallia Belgica, now the village *Moyland*, not far from Cologne.

**MEDIOLANUM Ordovicum** (anc. geogr.), a town of Britain, now *Llan Vethlin*, a market-town in Montgomeryshire in Wales.

**MEDIOLANUM Santonum** (anc. geogr.), which afterwards taking the name of the people, was called *Santonica Urbs*; also *Santonæ*; and *Santoni*: A town of Aquitain. Now *Saintes*, capital of Saintonge in Guienne, on the river Charente. W. Long. 36. 0. N. Lat. 45. 50.

**MEDITERRANEAN SEA**, extends from the Straits of Gibraltar to the coast of Syria and Palestine, being above 2000 miles in length, but of very unequal breadth; the west part of it separating Europe from Africa; and the Levant, or east part of it, dividing Asia from Africa, Spain, France, Italy, Turkey in Europe, and Natolia, or the Lesser Asia, bounding it on the north; and the empire of Morocco, Algiers, Tunis, Tripoli, Barca, and Egypt, bounding it on the south. The Strait of Gibraltar being about 15 or 16 miles broad, a strong current sets through it out of the Atlantic Ocean into the Mediterranean constantly, which requires a good gale of wind to stem it.

**MEDITULLIUM**, is used by anatomists for that spongy substance between the two plates of the *cranium*, and in the interstices of all laminated bones. See **DIPLOE**.

**MEDIUM**, in logic, the mean or middle term of a syllogism, being an argument, reason, or consideration, for which we affirm or deny any thing; or, it is the cause why the greater extreme is affirmed or denied of the less in the conclusion.

**MEDIUM**, in arithmetic, or *arithmetical medium* or *mean*, called in the schools *medium rei*; that which is equally distant from each extreme, or which exceeds the lesser extreme as much as it is exceeded by the greater, in respect of quantity, not of proportion; thus 9 is a medium betwixt 6 and 12.

**Geometrical MEDIUM**, called in the schools *medium personæ*, is that where the same ratio is preserved between the first and second as between the second and third terms; or that which exceeds in the same ratio or quota of itself, as it is exceeded: thus 6 is a geometrical medium between 4 and 9.

**MEDIUM**, in philosophy, that space or region through which a body in motion passes to any point: thus ether is supposed to be the medium through which the heavenly bodies move; air, the medium wherein bodies move near our earth; water, the medium wherein fishes live and move; and glass is also a medium of light, as it affords it a free passage. That density or consistency in the parts of the medium, whereby the motion of bodies in it is retarded, is called the *resistance of the medium*; which, together with the force of gravity, is the cause of the cessation of the motion of projectiles.

*Subtile* or *Æthereal MEDIUM*. See **ETHER**, **ELECTRICITY**, **FIRE**, &c.

**MEDIUM**, in optics, any substance through which light is transmitted.

**MEDLAR**, in botany. See **MESPILUS**.

**MEDULLA**,

*MEDULLA Oblongata*, } See **ANAT.** n<sup>o</sup> 5.

*MEDULLA Spinalis*. } 396—399.

**MEDUSA**, one of the three Gorgons, daughter of Ceto and a sea-god named *Phorcus*. Neptune being in love with her, forced her in the temple of Minerva; upon which that goddess changed her hair (which was extremely fair) into serpents, the sight of which turned the beholders into stones: but Perseus, armed with Mercury's ax, with which he killed Argus, cut off Medusa's head, from whose blood sprang Pegasus and Chrysaor. Minerva is represented bearing the picture of Medusa's head on her shield, to terrify her enemies.

**MEDUSA**, in zoology, a genus of insects belonging to the order of mollusca. The body is gelatinous, roundish, and depressed; and the mouth is in the centre of the under part of the body. There are twelve species, all natives of the sea. The most remarkable is the simplex, or armless, with a plain circumference; four apertures beneath; no tenacula. These animals inhabit all our seas; are gregarious; often seen floating with the tide in vast numbers; feed on insects, small fish, &c. which they catch with their clasps or arms. Many species, on being handled, affect with a nettle-like burning, and excite a redness. The ancients, and some of the moderns, add that they have an aphrodisiac property, and in several languages they are called by an obscene name. They were known to the Greeks and Romans by the names of *Πυλώα* or *Αραγρία*, and *pulmo marinus*, or sea-lings. They attributed medicinal virtues to them. Dioscorides informs us, that, if rubbed fresh on the diseased part, they cured the gout in the feet, and kided heels. Ælian says, that they were depilatory; and, if macerated in vinegar, would take away the beard. Their phosphoric quality is well known; nor was it overlooked by the ancients. Pliny observes, that if rubbed with a stick it will appear to burn, and the wood to shine all over. The same naturalist observes, that when they sink to the bottom of the sea, they portend a continuance of bad weather.

**MEGALE POLIS**, (anc. geogr.), dividedly (Ptolemy, Pansanias); or conjunctly *Megalopolis*, (Strabo): A town of Arcadia, built under the auspices of Epaminondas, after the battle of Leuctra; many considerable towns being joined together in one great city, the

Medium  
||  
Megale.

Megameter the better to withstand the Spartans. It was the greatest city of Arcadia, according to Strabo.

Meissner.

MEGAMETER. See MICROMETER.

MEGARA (anc. geog.), a noble city, and the capital of the territory of Megaris, which for many years carried on war with the Corinthians and Athenians. It had for some time a school of philologists, called the *Megarici*, successors of Euclid the Socratic, a native of Megara. Their dialect was the Doric; changed from the Attic, which it formerly had been, because of Peloponnesian colonists who settled there.

MEGARA (anc. geog.) formerly called *Hybla*, a town towards the east coast of Sicily; extinct in Strabo's time, though the name Hybla remained on account of the excellence of its honey. It was a colony of Megareans from Greece. *Rifus Megarius* denotes a hoarse-lantern.

MEGARIS (anc. geog.), the country of the Megareans, which Pliny makes a part of Attica; and Strabo says, some were of this opinion; but he himself makes it a distinct part; in which Scylax, Ptolemy, and the historians that relate the wars of the Athenians and Megareans, agree. It had Attica to the east, Bœotia to the north and west, and the Isthmus of Corinth to the south.

MEGARIS, a small island in the Tuscan sea, joined to Naples by a bridge. Now called *Castello dell' ovo*.

MEGIDDO, (Judges v. 19.) A town of Galilee, recited (Joshua xvii. 11.) among the cities of Manasseh, in the tribe of Issachar or Aser, on the west side of Jordan. Famous for the fate of Ahaziah and Josiah, who perished there: near it was an open plain, fit for drawing up an army in battle-array. It was situate to the north, contrary to its position in the common maps. The Canaanites being tributary to the Israelites, dwelt in it, Joshua xvii. It was rebuilt by Solomon, 1 Kings ix.

MEIBOMIUS, the name of several learned Germans.—*John Henry Meibomius* was professor of physic at Helmsdtadt, where he was born, and at Lubec; he wrote the *Life of Mæcenas*, published at Leyden in 4to. 1653, with several other learned works.—*Henry*, his son, was born at Lubec in 1638; became professor of physic at Helmsdtadt; and, besides works in his own profession, published *Scriptores rerum Germanicarum*, 3 vol. folio, 1688; a very useful collection, first begun by his father.—*Marcus Meibomius*, of the same family, published a collection of seven Greek authors who had written upon ancient music, with a Latin version by himself; dedicated to queen Christina of Sweden, who invited him to her court. But the engaging him one day to sing an air of ancient music, while somebody was ordered to dance to it, the immoderate mirth which this occasioned in the spectators so disgusted him, that he immediately left the court of Sweden. His edition of the Greek mythologists, and notes upon Diogenes Laertius in Menage's edition, shews him to have been a man of learning; but he suffered no little raillery for his attempt to correct the Hebrew text of the Bible, by a kind of metre he fancies he had found out in those ancient writings.

MEISSEN, a considerable town of Germany, in the electorate of Saxony, and in the margravate of Misnia, with a castle. It formerly belonged to the

bishop, but is now secularized, and the inhabitants are Lutherans. In this place is a famous manufactory of porcelain, E. Long. 13. 33. N. Lat. 51. 15.

Mela  
Melanc-  
thon.

MELA (Pomponius), an ancient Latin writer, was born in the province of Bœotia in Spain, and flourished in the reign of the emperor Claudius. His three books of Cosmography, or *De situ orbis*, are written in a concise, perspicuous, and elegant manner; and have been thought worthy of the attention and labours of the ablest critics. Isaac Vossius gave an edition of them in 1658, 4to. with very large and copious notes. To this edition is added *Julii Honorii oratoris excerptum cosmographicæ*, first published from the manuscript, and *Æthiici cosmographia*. Gronovius afterwards published another edition with illustrations by medals. In his last edition are added five books *De geographiâ*, written by some later author; by Jornandes, as Fabricius conjectures.

MELÆNA, or BLACK FLUX, in medicine. See MEDICINE, n<sup>o</sup> 495.

MELAMPYRUM, COW-WHEAT; a genus of the angiofermia order, belonging to the didymia class of plants. There are four species, all of them natives of Britain, and growing spontaneously among corn-fields. They are excellent food for cattle; and Linnaeus tells us, that where they abound the yellowest and best butter is made. Their seeds, when mixed with bread, give it a dusky colour; and, according to some authors, produce a vertigo, and other disorders of the head; but this is denied by Mr Withering, though he allows that they give it a bitter taste.

MELANCHOLY, a kind of delirium attended with gloomy thoughts, heaviness and sorrow. See MEDICINE, n<sup>o</sup> 185, 428, 429.

MELANTHON (Philip), born at Bretten in the Palatinate in 1495, was one of the wisest and most able men of his age among the Reformers, though of a mild temper, disposed to accommodate rather than inflame disputes. In his youth he made an admirable progress in learning, and was made Greek professor at Wirtemberg in 1509. Here his lectures upon Homer, and the Greek text of St Paul's epistle to Titus, drew to him a great number of auditors, and entirely effaced the contempt to which his low stature and mean appearance had exposed him. Melancthon reduced the sciences to systems; and acquired such reputation, that he had sometimes 2500 auditors. He soon entered into an intimate friendship with Luther, who taught divinity in the same university; and in 1519 they went together to Leipzig, to dispute with Eccius. The following years he was continually engaged in various employments; he composed several books; he taught divinity; took several journeys, in order to found colleges and visit churches; and in 1530 drew up a confession of faith, which goes by the name of the *Confession of Augsburg*, because it was presented to the emperor at the diet held in that city. All Europe was convinced, that he was not, like Luther, backward to accommodate the differences between the various sects of Christians. He hated religious disputes, and was drawn into them only through the necessity of the part he was called to act in the world; and therefore would have sacrificed many things, to have produced an union among the Protestants. For this reason, Francis I. the French king,

wrote:

Melan-  
thon.  
Melantria.

wrote to desire him to come and confer with the doctors of the Sorbonne, in order to agree with them about putting an end to all controversies; but though Luther endeavoured to persuade the elector of Saxony to consent to that journey, and though Melancthon himself desired it, that prince, whether he distrusted Melancthon's moderation, or was afraid of quarrelling with the emperor Charles V. would never grant his permission. The king of England also in vain desired to see him. Melancthon, in 1529, assisted at the conferences of Spire. In 1541, he was at the famous conferences at Ratibon. In 1543, he went to meet the archbishop of Cologne to assist him in introducing the reformation into his diocese; but that project came to nothing: and in 1548, he assisted at seven conferences on the subject of the interim of Charles V. and wrote a censure on that interim, and all the writings presented at these conferences. He was extremely affected at the dissensions raised by Flaccus Illyricus. His last conference with those of the Roman communion was at Worms, in 1557. He died at Wittenburg in 1560, and was interred near Luther. Some days before he died, he wrote upon a piece of paper the reasons which made him look upon death as a happiness; and the chief of them was, that it "delivered him from theological persecutions." Nature had given Melancthon a peaceable temper, which was but ill suited to the time he was to live in. His moderation served only to be his cross. He was like a lamb in the midst of wolves. No body liked his mildness; it looked as if he was lukewarm; and even Luther himself was sometimes angry at it.

Melancthon was a man in whom many good as well as great qualities were wonderfully united. He had great parts, great learning, great sweetness of temper, moderation, contentedness, and the like, which would have made him very happy in any other times but those in which he lived. He never affected dignities, or honours, or riches, but was rather negligent of all these things; too much so in the opinion of some, considering he had a family; and his son-in-law Sabiaius, who was of a more ambitious make, was actually at variance with him upon this very article. Learning was infinitely obliged to him on many accounts; on none more than this, that, as already observed, he reduced almost all the sciences which had been taught before in a vague irregular manner, into systems. Considering the distractions of his life, and the infinity of disputes and tumults in which he was engaged, it is astonishing how he could find leisure to write so many books. Their number is prodigious, inasmuch that it was thought necessary to publish a chronological catalogue of them in the year 1582. His works indeed are not correct, and he himself owned it: but as he found them useful, he chose rather to print a great number, than to finish only a few; "which however," as Bayle says, "was postponing his own glory to the advantage of others." His constitution was very weak, and required great tenderness and management; which made Luther, as hot and zealous as he was, blame him for labouring too earnestly in the vineyard.

MELANTERIA, in natural history, a very beautiful fossil, of a dense, compact, and regular texture,

and of an extremely bright pale yellow, resembling nothing so much as the purest gold. It is remarkably heavy; and is sometimes found in little irregular masses of the bigness of a pigeon's egg, which are broken with a slight blow; but it is usually met with in the form of a fine gold-coloured efflorescence on vitriolic and pyritical bodies; or in loose, shattery, and friable masses of a more dusky yellow; in which latter state it so much resembles a native sulphur, that it is frequently mistaken for one: however, it is not inflammable; but calcines in the fire to a greyish powder, which by burning longer changes to a deep and fine purple.

The Greeks used it externally, as a gentle escharotic and a styptic: they made it an ingredient in their ointments for old ulcers, and used to sprinkle the powder of it on fresh wounds in order to stop the hæmorrhage.

MELASTOMA, the AMERICAN GOOSEBERRY-TREE; a genus of the monogynia order, belonging to the decandria class of plants. There are a great many species, all of them natives of the warm parts of America, and very beautiful on account of the variegation of their leaves. Most of the leaves are of two different colours on their surfaces; the under side being either white gold-colour or russet, and their upper parts of different shades of green; so that they make a fine appearance in the hot-house all the year round. There are but few of these plants in the European gardens; which may perhaps have been occasioned by the difficulty of bringing over growing plants from the West Indies; and the seeds being small when taken out from the pulp of their fruits, rarely succeed. The best way is to have the entire fruits put up in dry sand as soon as they are ripe, and forwarded by the quickest contrivance to England. They should be immediately taken out when they arrive, and the seeds sown in pots of light earth, and plunged into a moderate hot-bed of tanner's bark. When the plants come up, and are fit to be removed, they must each be planted in a small pot, and plunged into the tan-bed; and afterwards treated as other exotic plants.

MELCHITES, in church-history, the name given to the Syriac, Egyptian, and other Christians of the Levant. The Melchites, excepting some few points of little or no importance, which relate only to ceremonies and ecclesiastical discipline, are in every respect professed Greeks: but they are governed by a particular patriarch, who resides at Damas, and assumes the title of *patriarch of Antioch*. They celebrate mass in the Arabian language. The religious among the Melchites follow the rule of St Basil, the common rule of all the Greek monks. They have four fine convents distant about a day's journey from Damas, and never go out of the cloister.

MELCHISEDECH, or MELCHISEDER, (the order of); an order of priesthood, according to the scriptures of the Old and New Testament.

The first mention of Melchisedech is in Genesis xv. 16, 17, 18. where it is related, that, when Abraham had rescued his brother Lot and all his goods out of the hands of the five kings, he was met, upon his return, by Melchisedech, king of Salem, who "brought forth bread and wine; and he was the priest of the Most High God." It is added, that he blessed Ab-  
bra-

Melastoma  
Melchise-  
dech.

Melchisedech.

braham; who acknowledged his priesthood, by giving him tythes of all he had taken from the enemy.

The next mention of Melchisedech is by the Royal Psalmist, who, speaking prophetically of the Messiah, says, "Thou art a priest for ever after the order of Melchisedech."

Lastly, St Paul applies the story of Melchisedech to our Saviour, citing the very words of the Psalmist. And, in another place, he gives this account of Melchisedech: "This Melchisedech, king of Salem, priest of the Most High God, who met Abraham returning from the slaughter of the kings, and blessed him; to whom Abraham gave a tenth part of all; first being by interpretation king of righteousness, and after that also king of Salem, which is, king of peace; without father, without mother, without descent; having neither beginning of days, nor end of life; but made like unto the Son of God, abideth a priest continually."

From these passages it appears, that Melchisedech, whoever he was, was a type of Jesus Christ, and his priesthood an image of our Saviour's.

Innumerable difficulties have been started upon the subject of Melchisedech. The first relates to his country, or the place where he reigned. Most authors take Salem to be the same as Jerusalem: but St Jerom places it near Scythopolis, where they still pretended to shew the ruins of Melchisedech's palace. He thinks it was at this place that Jacob arrived, after his passage over Jordan, when he returned from Mesopotamia.

The next difficulty relates to his person. It is generally agreed by learned men, that, when the apostle says he was *without father and without mother*, no more is meant than that he is introduced into the history of Abraham without acquainting us who he was or whence he came, when he lived or when he died. Nevertheless, some have taken St Paul's words literally, and contended, that he was not of human, but divine nature. Origen and Didymus took him to be an angel; and the author of the *Questions on the Old and New Testament* pretended he was the Holy Ghost, who appeared to Abraham in a human form.

About the beginning of the third century, arose the heresy of the Melchisedechians, who affirmed, that Melchisedech was not a man, but a heavenly power, superior to Jesus Christ: For Melchisedech, they said, was the intercessor and mediator of the angels; but Jesus Christ was so only for men, and his priesthood only a copy of that of Melchisedech. This heresy was revived in Egypt by one Hierax, who pretended that Melchisedech was the Holy Ghost.

The Arabic catena upon the ninth chapter of Genesis makes Melchisedech to be descended from Shem by his father, and from Japhet by his mother. Heraclas, or Heraclim, his father, was, they say, son or grandson of Phaleg, and son of Heber; and his mother, named *Salatibiel*, was daughter of Gomer, son of Japheth. Cedrenus, and others, derive Melchisedech from an Egyptian stock. They say his father was called *Sidon* or *Sida*, and was the founder of the city of Sidon the capital of Phœnicia. Suidas says, he was of the cursed race of Canaan; for which reason the scripture does not mention his genealogy.

The Jews and Samaritans believed Melchisedech to

be the same with the patriarch Shem; which opinion has been followed by a great number of modern writers. M. Jurieu has undertaken to prove, that he is the same as Cham or Ham. It would be endless to recount all the opinions upon this matter; we shall therefore only add, that Peter Cunæus, and Peter du Moulin, have asserted, that Melchisedech, who appeared to Abraham, was the Son of God; and that the patriarch worshipped him, and acknowledged him for the Messiah.

MELCOMB-REGIS, a town of Dorsetshire, in England, situated in W. Long. 2. 32. N. Lat. 50. 40. The streets are broad and paved; and there is an excellent harbour, by which they carry on a pretty good foreign trade.

MELEAGER, in fabulous history, the son of Æneas king of Caledonia, and Althæa the daughter of Thestius, was no sooner born than the Paræ put a firebrand in the fire, saying, "This child shall live as long as this firebrand shall last." The three Paræ being gone, Althæa took the brand out of the fire, and preserved it with great care. Meleager at length discovered great courage in killing the famous Caledonian boar which laid waste the country, and presented the head to Atalanta who had given the monster the first blow: but Plexippus and Toxeus, the brothers of Althæa, resolving to have the head, Meleager killed them in the quarrel, and married Atalanta, by whom he had Parthenope; but Althæa, in revenge for the death of her two brothers, threw the fatal brand on the fire, which occasioned Meleager's death.

MELEAGER, a Greek poet, the son of Eucrates, was born at Seleucia in Syria, and flourished under the reign of Seleucus VI. the last king of Syria. He was educated at Tyre; and died in the island of Coos, anciently called *Merope*. He there composed the Greek epigrams called by us the *Anthologia*. The disposition of the epigrams in this collection was often changed afterwards, and many additions have been made to them. The monk Planudes put them into the order they are in at present in the year 1380.

MELEAGRIS, in ornithology, the TURKEY, a genus of birds belonging to the order of gallinæ. The head is covered with spongy caruncles; and there is likewise a membranaceous longitudinal caruncle on the throat. There are three species, *viz.* 1. The gallopavo, or North American turkey of Ray, has a caruncle both on the head and throat; and the breast of the male is bearded. He lives upon grain and insects: when the cock struts, he blows up his breast, spreads and erects his feathers, relaxes the caruncle on the forehead, and the naked parts of the face and neck become intensely red.—Barbot informs us, that very few turkeys are to be met with in Guinea, and those only in the hands of the chiefs of the European forts; the Negroes declining to breed any on account of their tenderness, which sufficiently proves them not to be natives of that climate. He also remarks, that neither the common poultry nor ducks are natural to Guinea, any more than the turkey. Neither is that bird a native of Asia: the first that were seen in Persia were brought from Venice by some Armenian merchants. They are bred in Ceylon, but not found wild. In fact, the turkey, properly so called, was unknown to the ancient naturalists, and even to the old world, before

Melcombi  
Melcagr.

**Melos** before the discovery of America. It was a bird peculiar to the new continent, and is now the commonest wild-fowl in the northern parts of that country. It was first seen in France, in the reign of Francis I.; and in England, in that of Henry VIII. By the date of the reign of these monarchs, the first turkeys must have been brought from Mexico, the conquest of which was completed A. D. 1521. **Melian** mentions a bird found in India, which some writers have suspected to be the turkey; but Mr Pennant concludes, with Gessner, that it was either the peacock, or some bird of that genus. On consulting some gentlemen who had resided long in the Indies, Mr Pennant is of opinion, that though the turkey is bred there, it is only considered as a domestic bird, and not a native of the country.

2. The cristata, or Brasilian pheasant of Ray, has an erect crest of feathers on the head, and violet-coloured temples; it has a caruncle on the throat, but none on the head.

3. The fatyra, or horned pheasant of Edwards, has two blue horns behind its eyes, and a red body spotted with black and white. It is a native of Bengal.

**MELES**, in zoology. See **URSUS**.

**MELES**, (anc. geog.), a fine river running by the walls of Smyrna in Ionia, with a cave at its head, where Homer is said to have written his poems. And from it Homer takes his original name *Melastigenes*, given him by his mother Crithies, as being born on its banks. (Herodotus).

**MELIA**, **AZADERACH**, or the *Bead-tree*; a genus of the monogynia order, belonging to the decandria class of plants. There are three species, all of them exotic trees of the Indies, rising near 20 feet high; adorned with large pinnated or winged leaves, and clusters of pentapetalous flowers. They are all propagated by seeds sown on hot-beds.

**MELIANTHUS**, **HONEY-FLOWER**; a genus of the angiosperma order, belonging to the didynamia class of plants. There are two species. 1. The major hath a thick, ligneous, spreading root; many upright, ligneous, durable stalks, rising six or eight feet high; garnished with large pinnated leaves, of four or five pair of serrated lobes terminated by an odd one; and, from the sides and tops of the stalks, long spikes of chocolate-coloured flowers. 2. The minor, hath a root like the former; upright, ligneous, soft, durable stalks, rising four or five feet high; garnished with smaller pinnated leaves; and from the sides and ends of the branches, long, loose, pendulous bunches of flowers tinged with green, saffron colour, and red. Both the species flower about June; but rarely produce seeds in this country. They are very ornamental, both in foliage and flower, and merit admittance in every collection. They are easily propagated by suckers and cuttings. They thrive best in a dry soil, and in a sheltered warm exposure.

**MELIBOEA**, (anc. geog.), an island of Syria, at the mouth of the Orontes; which, before it falls into the sea, forms a spreading lake round it. This island was famous for its purple dye. Thought to be a colony of the Theslians; and hence Lucretius's epithet *Thesalicus*.

**MELICA**, **ROPEGRASS**; a genus of the digynia order, belonging to the triandria class of plants. There

are three species; of which the most remarkable is the **Meliceres**. It is a native of several parts of Britain and the adjacent islands; and the inhabitants of some of the western islands make ropes of it for fishing-nets, as it will bear the water for long time without rotting.

**MELICERES**, in surgery, a kind of encysted tumour, so called when their contents are of the consistence of honey.

**MELILLA**, an ancient town of Africa in the kingdom of Fez, and in the province of Garet. It was taken by the Spaniards in 1469, but returned back to the Moors. W. Long. 2. 9. N. Lat. 35. 20.

**MELILOT**. See **TRIFOLIUM**.

**MELINDA**, a kingdom on the east coast of Africa, situated, according to some, between the third and fourth degree of South Latitude; though there is great disagreement among geographers as to its extent. It is allowed by all, however, that the coasts are very dangerous; being full of rocks and shelves, and the sea at some seasons very liable to tempests. The kingdom of Melinda is for the most part rich and fertile; producing almost all the necessaries of life except wheat and rice, both which are brought thither from Cambodia and other parts; and those who cannot purchase them make use of potatoes in their stead, which are here fine, large, and in great plenty. They likewise abound with great variety of fruit-trees, roots, plants, and other esculents, and with melons of exquisite taste. They have also great plenty of venison, game, oxen, sheep, hens, geese, and other poultry, &c. and one breed of sheep whose tails weigh between 30 and 40 pounds. The capital city is also called *Melinda*.

**MELINUM**, in natural history, the name of an earth, famous in the earliest ages of painting, being the only white of the great painters of antiquity; and, according to Pliny's account, one of the three colours with which alone they performed all their works. It is a fine, white, marly earth, of a very compact texture, yet remarkably light; a sort of texture which must render any earth fit for the painter's use, that is of a proper colour. It is frequently found forming a stratum in the earth, lying immediately under the vegetable mould. It is of a very smooth but not glossy surface; is very soft to the touch; adheres firmly to the tongue; is easily broken between the fingers; and stains the skin in handling. It melts readily in the mouth, and is perfectly fine; leaving not the least grittiness between the teeth; thrown into water, it makes a loud bubbling and hissing noise, and moulders away into a fine powder. It does not ferment with acids; and suffers no change in the fire. These are the characters by which the melinum of the ancients is distinguished from all other white earths. It is still found in the same place from which the painters of old had it, viz. the isle of Milo or Melos, from whence it had its name; and is common in most of the adjacent islands. It has of late been tried here as a paint; but is found not to make such a bright paint as the other substances now employed. It is not, however, liable, like them, to turn yellow: hence it would seem to be worth the consideration of persons in the colour-trade; especially as it might be had, in any quantities, for the carriage.

**MELISSA**, **BAUM**; a genus of the gymnosperma order, belonging to the didynamia class of plants.

There

Melissa  
Melite.Melite  
Melite.

There are several species; but the most remarkable are the following. 1. The officinalis, or common baum, hath fibrous perennial roots; many upright, square, branchy, annual stalks, rising two or three feet high; garnished with oblong, indented, opposite leaves by pairs, two or three inches long, and half as broad; and, from the upper axillars, verticillate clusters of small white flowers, upon single footstalks. There is also a kind with variegated leaves. 2. The grandiflora, or Hetrurian calamint, hath fibrous perennial roots, and annual stalks, rising about a foot high; garnished with oblong, oval, indented, hairy opposite leaves; and from the upper axillars verticillate clusters of large purple flowers, on forked footstalks. 3. The calaminta, or common calamint of the shops, hath fibrous perennial roots; upright, square, branchy hairy stalks, rising a foot high; roundish, indented, opposite leaves; and verticillate clusters of small bluish flowers, on forked footstalks as long as the flowers. All these species are easily propagated by offsets.

*Medicinal Uses.* The first species, when in perfection, has a pleasant smell, somewhat of the lemon kind; and a weak, roughish, aromatic taste. The young shoots have the strongest flavour; the flowers, and the herb itself when old, or produced in very rich moist soils, or rainy seasons, is much weaker both in smell and taste. Baum is appropriated, by the writers on the materia medica, to the head, stomach, and uterus; and in all disorders of these parts, is said to do extraordinary service. So high an opinion have some chemists entertained of this plant, that they have expected to find in it a medicine which should prolong life beyond the usual period. The present practice, however, holds it in no great esteem; and ranks it (where it certainly deserves to be) among the weaker corroborants. Infusions of the leaves in water smell agreeably of the herb, but have not much taste, though on being inspissated they leave a considerable quantity of a bitterish austere extract. Infusions of baum do not, like other aromatics, offend the head, as is complained of from sage, &c. Cold infusions in water, or spirit, are far better than the cohobated distilled water, and are the best preparations from the plant. On distilling the fresh herb with water, it impregnates the first running pretty strongly with its grateful flavour. When large quantities are subjected to the operation at once, there separates and rises to the surface of the aqueous fluid a small portion of essential oil, which some call *of Syria*, and others *of Germanis*. It is of a yellowish colour, and a very fragrant smell.

MELISSUS of SAMOS, a Greek philosopher, was the son of Rhagines and the disciple of Parmenides; and lived about 520 B. C. The Ephesians gave him the post of admiral, and invested him with extraordinary power. He pretended that the universe is infinite, immovable, alone, and without a vacuum.

MELITE, (anc. geog.), an island referred to Africa by Scylax and Ptolemy; but nearer Sicily, and allotted to it by the Romans: commended for its commodious harbours; for a city well built, with artificers of every kind, especially weavers of fine linen; all owing to the Phœnicians, the first colonists. Now *Malta*; remarkable for St Paul's shipwreck.

MELITE, *Melita*, or *Melittina Insula*; an island on the coast of Illyricum in the Adriatic. *The Catuli Me-*  
Vol. VII

*litai*, (Pliny), were famous. Now *Melede*, the name of the island Samos.

MELITE, (anc. geog.), a town of Ionia, struck out of the number of Ionian towns on account of the arrogance of the people, and Smyrna admitted in lieu of it. The situation not fair.

MELITENSIS TERRA, the *Earth of Malta*: an earth, of which there are two very different kinds; the one of the genus of boles, the other of the marles. The latter is that known by medicinal authors under this name, the former is the Malta earth now in use; but both being brought from the same place, are confusedly called by the same name. The Maltese marle, which is the *terra Melitenfis* of medicinal authors, is a loose, crumbly, and very light earth, of an unequal and irregular texture; and, when exposed to the weather, soon falls into fine soft powder: but, when preserved and dried, it becomes a loose, light mass, of a dirty white colour, with a greyish cast: it is rough to the touch, adheres firmly to the tongue, is very easily crumbled to powder between the fingers, and stains the hands. Thrown into the water, it swells, and afterwards moulders away into a fine powder. It ferments very violently with acid menstrua. Both kinds are found in great abundance in the island of Malta, and the latter has been much esteemed as a remedy against the bites of venomous animals. The other has supplied its place in the German shops; and is used there as a cordial, sudorific, and astringent.

MELITO (canonized), bishop of Sardis in Lydia, in the second century; is remarkable for the apology he presented to the emperor Aurelius, in favour of the Christians; on which Eusebius and the other ancient ecclesiastical writers bestow great praises: but that apology and all Melito's other works, are lost.

MELITUS, Greek orator and poet, the accuser of Socrates. The Athenians, after the death of Socrates, discovering the iniquity of the sentence they had passed against that great philosopher, put Melitus to death 400 B. C.

MELLER, a lake of Sweden, 80 miles long, and 30 broad; on which stands the city of Stockholm.

MELLI, with the country of the Mundingoes, in Africa. The country formerly called *Melli*, now chiefly inhabited by the Mundingoes, who still retain pretty much of the character ascribed to the people of *Melli*, lies to the south of the river Gambia; on the west it borders on the kingdom of Kabo; on the south it has *Melli*, properly so called, and the mountains that part it from Guinea; and on the east it extends to the kingdom of Gago. A great part of this country we are little acquainted with; as is the case with regard to most of the inland territories of Africa, but towards the sea-coast this country is a little better known.

The first place of note we meet with is Kachao, a Portuguese colony, situated on the river of St Domingo, which falls into the sea about 26 leagues below this town.—About 26 leagues above Kachao, on the same side of the river, is another trading town called *Farii*, where, in the months of October and November, one may trade for about half the quantity of wax and ivory which is traded for at Kachao. Here are also some slaves to be bought.—Bot is a village near the mouth of the river Geives, where most of the traders buy rice; which is in great plenty there, and very

Melli,  
Melochia.

good.—Gefves is a village on a river of the same name, on which the Portuguese have a factory. At Gefves one may trade yearly for 250 slaves, 80 or 100 quintals of wax, and as many of ivory. Near the mouth of the river of Gefves is a village called *Kurbali*, where there is a considerable trade for salt: here are also some slaves and ivory. Rio Grande, or the Great River, runs about 10 or 12 leagues to the south of the river of Gefves. About 80 leagues from the mouth of it is a nation of Negroes, who are good traders in ivory, rice, millet, and some slaves. They are called *Analons*. Over-against the mouth of Rio Grande, is a cluster of islands called *Bissago Isles*; the most considerable of which is *Cassagut*, being about six leagues long and two broad; its soil is very good, and produces millet, rice, and all kinds of pulse, besides orange and palm-trees, and many others. This island, with those of Carache, Canabac, and La Gallina, are the only ones where the Europeans may trade with some security. They trade, however, sometimes at the other islands, but they must be extremely cautious; and yet, after all their precautions, they will be robbed and murdered if they venture to go ashore. The river Nunho runs 16 leagues to the south of Rio Grande; it is very considerable, and comes from a vast distance in land. One may buy here 300 quintals of ivory and 100 slaves a-year. Rice grows here admirably well, and is very cheap. There are every-where sugar-canes which grow naturally; and plants of indigo, which might turn to good account. The trade is carried on here from March till August. In the river of Sierra Leone, the late Royal African company of England had, in the year 1728, two islands; the one, called *Tasso*, a large flat island, near three leagues in circumference, in which the company's slaves had a good plantation: the rest of the island is covered with wood, among which are silk cotton-trees of an unaccountable size. The other island is *Benfe*, whereon stood a regular fort. It was formerly the residence of one of the English chiefs.

**MELOCHIA, JEWS MALLOW**; a genus of the pentandria order, belonging to the monodelphia class of plants. There are several species; but the only remarkable one is the olitorius, or common Jews-mallow, which is a native of the warm parts of Asia and America. It is an annual plant, which rises about two feet high, dividing into several branches, garnished with leaves of different sizes and forms: some are spear-shaped, others are oval, and some almost heart-shaped: they are of a deep green, and slightly indented on their edges, having near their base two bristly reflexed segments. They have very long slender footstalks, especially those which grow on the lower part of the branches. The flowers sit close on the opposite side of the branches to the leaves, coming out singly; they are composed of five small yellow petals, and a great number of stamina surrounding the oblong germen, which is situated in the centre of the flower and afterwards turns to a rough swelling capsule two inches long, ending in a point, and having four cells filled with angular greenish seeds. This species is cultivated about the city of Aleppo in Syria, and in the East Indies, as a pot-herb; the Jews boiling the leaves, and eating them with their meat. It is supposed by Rauwolf to be the *clav. Fua-*

*daicum* of Avicenna, and the *corchorum* of Pliny.

**MELODUNUM**, (anc. geog.), Cæsar; a town of the Senones in Gallia Celtica above Lutetia; now *Melan*, in the ile of France on the Seine.

**MELODY**, in music, a succession of sounds ranged in such a manner, according to the laws of rhythmus and modulation, that it may form a sentiment agreeable to the ear. Vocal melody is called *singing*; and that which is performed upon instruments may be termed *symphonic melody*.

The idea of rhythmus necessarily enters into that of melody. An air is not an air but in proportion as the laws of measure and quantity are observed. The same succession of sounds is susceptible of as many different characters, as many different kinds of melody, as the various ways by which its emphatic notes, and the quantities of those which intervene, may be diversified; and the change in duration of the notes alone, may disguise that very succession in such a manner that it cannot be known. Thus, melody in itself is nothing; it is the rhythmus or measure which determines it, and there can be no air without time. If then we abstract measure from both, we cannot compare melody with harmony; for to the former it is essential, but not at all to the latter.

Melody, according to the manner in which it is considered, has a relation to two different principles. When regarded only as agreeable to the proportions of sound and the rules of modulation, it has its principle in harmony; since it is a harmonical analysis, which exhibits the different gradations of the scale, the chords peculiar to each mode, and the laws of modulation, which are the sole elements that compose an air. According to this principle, the whole power of melody is limited to that of pleasing the ear by agreeable sounds, as the eye may be pleased with an agreeable assemblage of suitable colours. But when considered as an imitative art, by which we may affect the mind with various images, excite different emotions in the heart, inflame or soothe the passions; by which, in a word, we produce different effects upon our moral faculties, which are not to be effectuated by the influence of external sense alone, we must explore another principle for melody: for in our whole internal frame there appears to be no power upon which either harmony alone, or its necessary results, can seize, to affect us in such a manner.

What then is the second principle? It is as much founded on nature as the first; but, in order to discover its foundation in nature, it will require a more accurate though simpler observation, and a more exquisite degree of sensibility in the observer. This principle is the same which varies the tone of the voice, when we speak, according as we are interested in what we say, and according to the different emotions which we feel in expressing it. It is the accent of languages which determines the melody of every nation; it is the accent which determines us to employ the emphatics of speaking while we sing, and to speak with more or less energy according as the language which we use is more or less accented. That language whose accents are the most sensible, ought to produce a more passionate and more lively melody; that which has little accentuation, or none at all, can only produce a cold and languid melody, without cha-

Melodo-  
num,  
Melody.



acter and without expression. These are the true principles: in proportion as we depart from them, when we speak of the power of music upon the humanheart, we shall become unintelligible to ourselves and others; our words will be without meaning.

If music does not impress the soul with images but by melody, if from thence it obtains its whole power, it must follow, that all musical sounds which are not pleasing by themselves alone, however agreeable to harmony they may be, is not an imitative music; and, being incapable, even with its most beautiful chords, either to present the images of things, or to excite the finer feelings, very soon cloy the ear, and leaves always the heart in cold indifference. It follows likewise, that notwithstanding the parts which harmony has introduced, and which the present taste of music so wantonly abuses, wherever two different melodies are heard at the same time, they counteract each other, and destroy the effects of both, however beautiful each may be when performed alone: from whence it may be judged with what degree of taste the French composers have introduced in their operas the miserable practice of accompanying one air with another, as well in singing, which is the native expression of passions and sentiment, as in instrumental performances; which is the same thing as if whimsical orators should take it in their heads to recite two orations at the same time, that the elegance of each might derive more force from the other.

So much for Rousseau. The translator, however, has reason to fear, that the causes by which national melody is diversified and characterised, are more profound and permanent than the mere accentuation of language. This indeed may have great influence in determining the nature of the rhythms, and the place of emphatic notes; but very little in regulating the nature of the emphasis and expression themselves. If Rousseau's principle be true in its full extent, he must of necessity acknowledge, that an air which was never set or intended for words, however melodious, cannot be imitative: he must likewise confess, that what is imitative in one nation cannot be such in another: nor can it be denied upon his hypothesis, that the recitative, which is formed upon the mode of speaking, is the most forcible of all melodies; which is absurd. His other observations are at once judicious and profound. Though it is impossible to exhibit the beauty and variety of harmony by playing the same melody at the same time upon different keys, admitting those keys to form among themselves a perfect chord, which will of consequence preserve all the subsequent notes in the same intervals; yet this perfect harmony would by no means be uniformly pleasing to the ear. We must therefore of necessity introduce less perfect chords to vary and increase the pleasure, and these chords in any complex system of music must of necessity produce dissonances. It then becomes the business of the composer to be careful that these discords may arise as naturally from, and return as naturally to, perfect harmony as possible. All these causes must inevitably vary the melody of the different parts; but still amidst all these difficulties, the artist ought to be zealous in preserving the melody of each as homogeneous with the others as possible, that the result of the whole may

be in some measure uniform. Otherwise, by counteracting each other, the parts will reciprocally destroy the effects one of another.

MELOE, in zoology, a genus of insects of the order of coleoptera. The antennæ are jointed, the last joint being oval; the breast is roundish; the elytra are soft and flexible; and the head is inflexed and gibbous. There are 16 species, principally distinguished by their colour. The most remarkable is the vesicatorius, or cantharis of the shops; which, when bruised, is universally used as a blistering plaster. These insects are of a shining green colour, intermingled with more or less of a blue and a gold yellow. They are found adhering to different kinds of trees and herbs, in Spain, Italy, and France: the largest and most esteemed come from Italy.

Cantharides are extremely acrimonious: applied to the skin, they first inflame, and afterwards excoriate the part, raising a more perfect blister than any of the vegetable acids, and occasioning a more plentiful discharge of serum. All the blistering compositions have cantharides for their basis. The external application of cantharides is often followed by a strangury, accompanied with thirst and feverish heat: this inconvenience may be remedied by soft unctuous or mucilaginous liquors liberally drank.

Cantharides taken internally often occasion a discharge of blood by urine, with exquisite pain: if the dose is considerable, they seem to inflame and exulcerate the whole intestinal canal; the stools become mucous and purulent; the breath fetid and cadaverous; intense pains are felt in the lower belly; the patient faints, grows giddy, raving mad, and dies. All these terrible consequences have sometimes happened from a few grains. Herman relates, that he has known a quarter of a grain inflame the kidneys, and occasion bloody urine with violent pain. There are nevertheless cases in which this stimulating fly, given in larger doses, proves not only safe, but of singular efficacy for the cure of diseases that yield little to medicines of a milder class. In cold phlegmatic sluggish habits, where the viscera are overloaded, and the kidneys and ureters obstructed with thick viscid mucous matter, cantharides have excellent effects: here the abounding mucus defends the solids from the acrimony of the fly, till it is itself expelled; when the medicine ought to be discontinued. Groenvelt employed cantharides with great success in dropsies, obitinate suppressions of urine, and ulcerations of the bladder; giving very considerable doses made into boluses with camphor; and interposing large draughts of emulsions, milk, or other emollient liquids: by this means, the excessive irritation, which they would otherwise have occasioned, was in great measure prevented. The camphor did not perhaps contribute so much to this effect as is generally imagined: since it has no sensible quality that promises any considerable abatement of the acrimony of cantharides: nitre would answer all that the camphor is supposed to perform; this, with milk, or emollient mucilaginous liquors, drank in large quantity, are the best correctors. Cantharides, in very small doses, may be given with safety also in other cases. Dr Mead observes, that the obitinate gleetings which frequently remain after the cure of venereal maladies, and which rarely yield to balsamic medi-

Melon  
Melt.

cines, are effectually remedied by cantharides; and that no one remedy is more efficacious in leprous disorders; in which last, proper purgatives are to be occasionally taken during the use of the cantharides. The best and safest preparation of cantharides for these purposes, is a spirituous tincture; and indeed in all cases, the tincture is far preferable, for internal use, to the fly in substance.

The virtues of cantharides are extracted by rectified spirit of wine, proof spirit, and water; but do not arise in distillation. The watery and spirituous extracts blister as freely as the fly in substance; whilst the fly remaining after the several menstrua have performed their office, is to the taste insipid, and does not in the least blister or inflame the skin.

MELON, in botany. See *CUCUMIS*.

MELOTHRIA, in botany; a genus of the monogynia order, belonging to the triandria class of plants. There is only one species, viz. the pendula, a native of Carolina, Virginia, and also many of the American islands. The plants strike out roots at every joint, which fasten themselves into the ground, by which means their stalks extend to a great distance each way. The flowers are very small, in shape like those of the melon, of a pale sulphur colour. The fruit in the West Indies grows to the size of a pea, is of an oval figure, and changes to black when ripe: these are by the inhabitants sometimes pickled when they are green. In Britain the fruit are much smaller, and are so hidden by the leaves that it is difficult to find them. The plants are too tender to be reared in this country without artificial heat.

MELPOMENE, in fabulous history, one of the nine muses, and the inventress of tragedy. She is commonly represented with a serious countenance, and in a theatrical dress, holding crowns and sceptres in one hand, and a dagger in the other.

MELREY, or MELROSE, a town of Scotland, in the county of Merse, and on the confines of Tweedale, seated on the south-side of the river Tweed; with an ancient abbey now in ruins. W. Long. 2. 32. N. Lat. 55. 32.

This abbey was founded by king David I. in 1136. He peopled it with Cisterians, brought from Rivalde abbey in Yorkshire, and dedicated it to the virgin Mary. At the reformation James Douglas was appointed commendator, who took down much of the building, in order to furnish materials for a large house to himself, which still remains, and is dated 1590. Nothing is left of the abbey, excepting a part of the cloister walls, elegantly carved; but the ruins of the church are of most uncommon beauty. Part is at present used for divine service, the rest uncovered; but every part does great honour to the architect.—Alexander II. was buried beneath the great altar, and it is also the place of interment of the Douglasses and other potent families.—Its situation is extremely pleasant.

MELT OF FISHES. In the melt of a living cod there are such numbers of those animalcules said to be found in the semen of all male animals, that in a drop of its juice, no larger than a grain of sand, there are contained more than 70,000 of them; and, considering how many such quantities there are in the whole melt

of one such fish, it is not incredible, that there are more animals in one melt of it, than there are living men at one time upon the face of the earth. However strange and romantic such a conjecture must appear, a serious consideration and calculation will make it appear very plain. An hundred such grains of sand as those just mentioned will make about an inch in length; therefore in a cubic inch there will be a million of such sands; and if there be 10,000 animals in each of those quantities, there must be in the whole 150,000 millions; which is a number vastly exceeding that of mankind, even supposing the whole earth as populous as Holland.

MELTING CONE, in essaying, an hollow cone of brass or cast iron, into which melted metalline substances are thrown, in order to free them from their scorize. When a small quantity of matter is melted, it will be sufficient to rub the inside of the cone with grease; but when the quantity is very large, especially if it contains any thing sulphureous, this caution of tallowing the moulds is not sufficient. In this case the essayer has recourse to a lute reduced to thin pap with water, which effectually prevents any injury to the cone.

MELVIL (Sir James), descended from an honourable Scots family, being the third son of the laird of Kaeth, was born about the middle of the 16th century. He went to France, very young, in the capacity of page to queen Mary, then married to the dauphin; and on the death of her husband, followed her to Scotland, where he was made gentleman of her chamber, and admitted a privy-counsellor. She employed him in her most important concerns, till her unhappy confinement in Lochleven, all which he discharged with the utmost fidelity; and, from his own accounts, there is reason to conclude, that, had he taken his advice, she might have avoided many of her misfortunes. When he was prisoner in England, she recommended him strongly to her son James; with whom he continued in favour and employement until the death of queen Elizabeth: James would then have taken him to England; but Melvil, now grown old, was desirous of retiring from business, and in his retirement he drew up the memoirs of his past life for the use of his son. These memoirs were accidentally found in Edinburgh castle, in the year 1660, though nobody knew how they came to be deposited there; and were published in folio in 1683.

MEMBER, in architecture, denotes any part of a building; as a frieze, cornice, or the like. This word is also sometimes used for the moulding.

MEMBER of Parliament. See PARLIAMENT.

MEMBRANE, in anatomy, a pliable texture of fibres interwoven together in the same plane.

MEMNON, in fabulous history, was the son of Tithonus and Aurora. Having led his troops to the assistance of Priam, in order to raise the siege of Troy, he was killed by Achilles; when his body being placed on a funeral pile, was, at Aurora's desire, transformed into a bird.

MEMNON of Rhodes, one of the generals of Darius king of Persia, advised that prince to lay waste the country, in order to deprive Alexander the Great's army of support, and afterwards to attack Macedonia; but

Melting  
Memnon.

but this counsel was disapproved by Darius's other generals. Memnon behaved at the passage of the Granicus like an experienced general. He afterwards defended the city of Miletum with great courage; seized the islands of Chio and Lesbos; spread terror throughout all Greece; and would have put a stop to the conquests of Alexander, if he had not been prevented by death. Barina, Memnon's widow, was taken prisoner with Darius's wife, and Alexander had a son by her named *Hercules*.

MEMOIRS, in matters of literature, a species of history, written by persons who had some share in the transactions they relate; answering to what the Romans called *Commentarii*.—The journals of the proceedings of a literary society, or a collection of matters transacted therein, are likewise called *Memoirs*.

MEMORY, a faculty of the human mind, whereby it retains and recalls the ideas it has once perceived. See METAPHYSICS, n<sup>o</sup> 42.

Memory depends very much upon the temper and constitution of the body. In some, it is not so susceptible of impressions; in others, it is not sufficiently retentive: and as the feat of the memory is in the brain, whatever is hurtful to this latter, must prejudice the former. Too much sleep clouds the brain, and too little over-heats it; therefore either of these extremes must of course hurt the memory. All intemperance likewise, and excess of passion, have the same ill effect.

When we would commit any thing to memory, our first concern should be to understand it thoroughly. For we can never retain those things long, of which we have but an imperfect knowledge. Likewise order and method in the discourse itself is a great help to the memory. Where things have a mutual dependence upon each other, and go on in a series, the thoughts pass more readily from one to another, than where they lie confused and without any connection. The mind should also be free at such times, and have nothing else to take off its attention. Nothing is a greater hindrance to the memory than a crowd of ideas, and those of different kinds, flowing in upon the mind at the same time. They jumble out one another, so that but few of them settle; and if they do, it is in such a confused and disorderly manner, that when they come to be surveyed by reflection, little can be made of them.

To write down any thing is likewise a great advantage towards remembering it. For the very action of writing helps very much to imprint it upon the mind, by engaging it to a closer attention, and causing it to dwell longer upon every part than otherwise it would do only in reading. And therefore the Jewish doctors tell us, it was for this reason that the kings of Israel were enjoined always to write out a copy of the law with their own hand. And the fairer a thing is written, it is with greater ease committed to memory. This may possibly at first seem to have little in it; but if we consult experience, we shall generally find, that those things make the deepest impression upon the mind, which affect the senses in the most lively and agreeable manner. As we receive most of our ideas through them, the stronger impulse is made upon the organ, the greater attention it excites in the mind; and what we most attend to,

we retain longest.

A little experience and observation will help a person to discover the strength of his memory. And care should be taken not to over-burden it. A long discourse therefore should be committed to memory by parts, so much at once as the memory can well receive and retain. These parts should not be too many, for fear of confusion. And as it is most likely we may be at a loss in passing from one part to another, it will not be amiss in a more particular manner to impress upon the mind the beginnings of them. One letter often helps us to recover a word; that word a sentence; and the first sentence a whole argument. Some have therefore advised, for the assistance of weaker memories, to write each part of the discourse in a separate paragraph, and the first word in larger characters, which may strike the fancy like a picture when we come to those places. For every one is sensible of the powerful effect of imagery to excite and recall our ideas: and therefore it has been thought a further advantage, if the first letter of each word, written in larger characters, could be joined together in one artificial word; for then the remembrance of that word would give us the first letter of each of those initial words, which letters would help us to recollect the whole words, which was the thing designed by writing them in different characters. We find this method of bringing several ideas together into one artificial word of use in other cases. So the figures of syllogisms being distinguished by technical words, are better known, and more easily remembered; as every one perceives, who is conversant in logic.

As the mind is not at all times equally disposed for the exercise of this faculty, such seasons should be made choice of as are most proper for it. The mind is seldom fit for attention presently after meals; and to call off the spirits at such times from their proper employment in digestion, is apt to cloud the brain, and prejudice the health. Both the mind and body should be easy and undisturbed when we engage in this exercise, and therefore retirement is most fit for it: and the evening, just before we go to rest, is generally recommended as a very convenient season, both for the stillness of the night, and because the impressions will then have a longer time to settle before they come to be disturbed by the accession of others proceeding from external objects; and to call over in the morning what has been committed to the memory over-night, must, for the same reason, be very serviceable. For, to review those ideas while they continue fresh upon the mind, and unmixed with any others, must necessarily imprint them more deeply.

Some ancient writers speak of an artificial memory, and lay down rules for attaining it. Simonides the poet is said first to have discovered this, or at least to have given the occasion for it. The story they tell of him is this: Being once at a feast, he recited a poem which he had made in honour of the person who gave the entertainment. But having (as is usual in poetry) made a large digression in praise of Cætor and Pollux; when he had repeated the whole poem, his patron would give him but half the sum he had promised, telling him he must get the other part from  
those

Memory. those deities who had an equal share in the honour of his performance. Immediately after, Simonides was told that two young men were without, and must needs speak with him. He had scarce got out of the house, when the room where the company was fell down, killed all the persons in it, and so mangled their bodies, that, when the rubbish was thrown off, they could not be known one from another: upon which Simonides recollecting the place where every one had sat, by that means distinguished them. Hence it came to be observed, that to fix a number of places in the mind in a certain order, was a help to the memory: As we find by experience, that, upon returning to places once familiar to us, we not only remember them, but likewise many things we both said and did in them. This action therefore of Simonides was afterwards improved into an art, and the nature of it is this: They bid you form in your mind the idea of some large place or building, which you may divide into a great number of distinct parts, ranged and disposed in a certain order. These you are frequently to revolve in your thoughts, till you are able to run them over one after another without hesitation, beginning at any part. Then you are to impress upon your mind as many images of living creatures, or any other sensible objects which are most likely to affect you, and be soonest revived in your memory. These, like characters in short-hand, or hieroglyphics, must stand to denote an equal number of other words, which cannot so easily be remembered. When therefore you have a number of things to commit to memory in a certain order, all that you have to do is, to place these images regularly in the several parts of your building. And thus they tell you, that, by going over several parts of the building, the images placed in them will be revived in the mind; which of course will give you the things or words themselves in the order you desire to remember them. The advantages of the images seems to be this; that, as they are more like to affect the imagination than the words for which they stand, they will for that reason be more easily remembered. Thus, for instance, if the image of a lion be made to signify *strength*, and this word *strength* be one of those I am to remember, and is placed in the porch; when in going over the several parts of the building I come to the porch, I shall sooner be reminded of that image than of the word *strength*. Some ancient as well as modern writers relate wonderful effects of this artifice. But they all agree it much more afflicts us to remember any number of separate and unconnected words, than a continued discourse; unless so far as the remembrance of one word may enable us to recollect more. And in this respect it does not much differ from some of those methods above-mentioned as helps to the memory. Quintilian therefore, though he does not wholly pass it over, yet seems to lay no great stress upon it.

And, doubtless, the most effectual way to gain a good memory is, its constant and moderate exercise.—In a word, the memory, like other habits, is strengthened and improved by daily use and practice. Wherefore those who have most occasion for it, as orators, should not suffer it to lie idle, but constantly employ it in treasuring up and frequently reviewing such things as may be of most importance to them.—

For by this means it will be more at their command, and they may put greater confidence in it upon any emergent occasion.

Another method of affixing the memory, is by forming certain words, the letters of which shall signify the date or æra to be remembered. In order to this, the following series of vowels, diphthongs, and consonants, together with their corresponding numbers, must be exactly learned; so as to be able at pleasure to form a technical word that shall stand for any number, or to resolve such a word already formed.

a	e	i	n	u	a	oi	ei	ou	y
1	2	3	4	5	6	7	8	9	o
b	d	t	f	l	s	p	k	n	z

The first five vowels, in order, naturally represent 1, 2, 3, 4, 5; the diphthong *au*=6, as being composed of *a* and *u*, or  $1+5=6$ ; and for the like reason, *oi*=7, and *ou*=9. The diphthong *ei* will easily be remembered for 8, as being the initials of the word. In like manner, where the initial consonants could conveniently be retained, they are made use of to signify the number, as *t* for 3, *f* for 4, *s* for 6, and *n* for 9. The rest were assigned without any particular reason, unless that possibly *p* may be more easily remembered for 7 or *septem*, *k* for 8 or *octo*, *d* for 2 or *duo*; *b* for 1, as being the first consonant; and *l* for 5, being the Roman letter for 50, than any others that could have been put in their places.

It is to be further observed, that *z* and *y* being made use of to represent the cypher, where many cyphers meet together, as 1000, 1000000, &c. instead of a repetition of a *z y z y z y*, &c. let *g* stand for 100, *th* for a thousand, and *m* for a million. Thus *ag* will be 100, *ig* 300, *oug* 900, &c. *ath* 1000, *am* 1000000, *loum* 5900000, &c.

Fractions may be set down in the following manner: let *r* signify the line separating the numerator and denominator, the first coming before, the other after it; as *iro*  $\frac{1}{2}$ , *urp*  $\frac{2}{3}$ , *pourag*  $\frac{7}{10}$ , &c. When the numerator is 1 or unit, it need not be expressed, but begin the fraction with *r*; as *re*  $\frac{1}{2}$ , *ri*  $\frac{1}{3}$ , *ro*  $\frac{1}{4}$ , &c. So in decimals, *rag*  $\frac{1}{10}$ , *rath*  $\frac{1}{100}$ .

This is the principal part of the method which consists in expressing numbers by artificial words. The application to history and chronology is also performed by artificial words. The art herein consists in making such a change in the ending of the name of a place, person, planet, coin, &c. without altering the beginning of it, as shall readily suggest the thing sought, at the same time that the beginning of the word, being preserved, shall be a leading or prompting syllable to the ending of it so changed. Thus, in order to remember the years in which Cyrus, Alexander, and Julius Cæsar, founded their respective monarchies, the following words may be formed; for Cyrus, *Cyruis*; for Alexander, *Alexitia*; for Julius Cæsar, *Julior*. *Uis* signifies, according to the powers assigned to the letters before-mentioned, 536; *ita* is 331, and *or* is 46. Hence it will be easy to remember, that the empire of Cyrus was founded 536 years before Christ, that of Alexander 331, and that of Julius Cæsar 46. This account is taken from a treatise, entitled *A New Method of Artificial Memory*; where the reader will find several

Memphis  
Menander.  
ral examples in chronology, geography, &c. of such artificial words disposed in verses, which must be allowed to contribute much to the assistance of the memory, since being once learned they are seldom or never forgot. However, the author advises his reader to form the words and verses himself, in the manner described above, as he will probably remember these better than those formed by another.

We shall here give his table of the kings of England since the conquest; where 1000 being added to the italics in each word, expresses the year when they began their reigns. Thus,

Will-*consiau*, Ruf *koi*, Henrag.

Steph<sup>h</sup>il & Henfeckuf; Richbein, Jann, Hethdas & Eddsid

Ediety, Edartep, Rifetoi, Hefotoun, Hefifadque.

Henfid, Edquafauz, Efi Rokt, Henfevil, Henuclen.

Ediexlo, Marylut, Elsluk, Jamfid, Caroprimsf.

Carfeckok, Jamfefj, Wilfeti, Anyyd, Geobodo.

MEMPHIS, an ancient city, and the royal residence of the kings in the Higher Egypt; distant from the Delta to the south 15 miles, according to Pliny. Situate on the west side of the Nile, over-against Babylon. Famous for its pyramids, the burial-places of the kings. In Strabo's time it was flourishing and populous, and second to Alexandria. Called also *Moph* and *Noph*, in scripture.

MENAGE (Giles), in Latin *Figidius*, a celebrated French writer, born at Angers in 1613. He finished his studies in that city, was made advocate, and pleaded for some time at Angers, Paris, and Poitiers; but, becoming at length disgusted with the bar, turned ecclesiastic, and gave himself up entirely to the study of polite literature. He at length entered into the family of the cardinal de Retz; but disagreeing with some persons belonging to his eminence, went to live in the cloyster of Notre Dame, where he held an assembly of learned men every Wednesday. He read a great deal; had a prodigious memory; and was incessantly quoting in his conversation, verses in Greek, Latin, Italian, French, &c. on which account he was often turned into ridicule by the wits, especially towards the end of his days. His great memory he retained even in his old age; and what is very rare, it returned to him after some interruption. The reputation of his works procured him a place in the academy *della Crusca* at Florence. He might have been a member of the French academy at its first institution, if it had not been for his *Requête des Dictionnaires*: but when that was forgot, he was proposed in 1684 to fill up a vacant place in that academy, and was excluded only by the superior interest of his competitor Mr Bergent; for there was not one member of all those who gave their votes against him, but owned that he deserved the place. He would not suffer his friends to propose him again. He died at Paris in 1692, aged 79. He wrote a great number of books in prose and verse; the principal of which are, 1. Miscellaneous works. 2. The Origin of the French Language. 3. The Origin of the Italian Tongue; the best edition of which is that of Geneva, in 1685, folio. 4. An edition of Malherbe's Poems, with Notes. 5. An edition of Diogenes Laertius, with Observations. 6. Remarks on the French Tongue. 7. Greek, Latin, Italian, and French poems.

MENANDER, an ancient Greek poet, was born

at Athens in the same year with Epicurus, which was the third of the 100th olympiad. His happiness in introducing the new comedy, and refining an art which had been so gross and licentious in former times, quickly spread his name over the world. Pliny informs us, that the kings of Egypt and Macedon gave a noble testimony of his merit, by sending ambassadors to invite him to their courts, and even fleets to bring him over; but that Menander was so much of a philosopher, as to prefer the free enjoyment of his studies to the promised favours of the great. Of his works, which amounted to above 100 comedies, we have had a double loss, the originals being not only vanished, but the greatest part of them, when copied by Terence, having unfortunately perished by shipwreck before they saw Rome. Yet the four plays which Terence borrowed from him before that accident happened, are still preserved in the Roman habit; and it is chiefly from Terence that most people form their judgment of Menander, the fragments that remain of him not being sufficient to enable them to do it. The ancients have said high things of Menander; and we find the old masters of rhetoric recommending his works, as the true patterns of every beauty and every grace of public speaking. Quintilian declares, that a careful imitation of Menander only, will satisfy all the rules he has laid down in his Institutions. It is in Menander that he would have his orator search for a copiousness of invention, for a happy elegance of expression, and especially for that universal genius which is able to accommodate itself to persons, things, and affections.

But Julius Cæsar has left the loftiest as well as the justest praise of Menander's works, when he calls Terence only a *Half-Menander*. For while the virtues of the Latin poet are so deservedly admired, it is impossible we should raise a higher notion of excellency, than to conceive the great original still shining with half its lustre unreflected, and preserving an equal part of its graces, above the power of the best copier in the world.

Menander died in the 3d year of the 122d olympiad, as we are taught by the same old inscription from which we learn the time of his birth. His tomb, in Pausanias's age, was to be seen at Athens, in the way from the Piræus to the city, close by the honorary monument of Euripides. Quintilian, in his judgment of Afranius the Roman comedian, who imitated him, censures Menander's morals as much as he commends his writings; and his character, according to Suidas, is, that he was a very "mad fellow after women." Phædrus has given him the gait and dress of a most affected fop:

"Unguento delibutus, vestitu adfusus,  
"Veniebat greffu delicatulo & languido."

*Lib. v. fæb. 2.*

MENASSEH (Ben Israel), a celebrated rabbi, born in Portugal about the year 1604, was the son of Joseph Ben Israel, and followed his father into Holland, where he was educated by rabbi Isaac Uziel, under whom, he in a short time made such progress in the Hebrew tongue, that at 18 years of age he succeeded him in the synagogue of Amsterdam, in which post he continued several years, and married Rachel of the family of the Abarbaucels, whom the Jews imagine to be descended from king David. He afterwards

Menander,  
Menaffch.

went to his brother Ephraim, a rich merchant, who had settled at Basil; by whose advice he entered into trade. Some time after, the hopes of a more agreeable settlement induced him to come into England, under the protection of Cromwell; who gave him a very favourable reception, and one day entertained him at his table with several other learned divines. However, he soon after passed into Zealand; and died at Middleburg about the year 1657. The Jews at Amsterdam obtained his body, and interred it at their expense. He was of the sect of the Pharisees; had a lively wit, a solid judgment, great learning, and all the virtues that can adorn private life. He wrote many works in Hebrew, Latin, Spanish, and English. The principal of those published in Latin, are, 1. *His Conciliator*; a learned and curious work, in which he reconciles those passages of Scripture which seem to contradict each other. 2. *De resurrectione mortuorum*. 3. *De termino vite*. 4. *Dissertatio de fragilitate humana, ex lapsu Adami, deque Divino in bono opere auxilio*. 5. *Spes Israel*. Dr Thomas Pococke has written his life in English.

MENCKE (Lewiss Otto), in Latin *Menckenius*, a learned professor of morality at Leipzig, was born at Oldenburg in Westphalia in 1644. He studied in several universities of Germany; and became an able philosopher, civilian, and divine. He was made professor of morality at Leipzig in 1668; and enjoyed that post to his death. He was five times rector of the university of that city, and seven times dean of the faculty of philosophy. He published several works; but his most considerable, and what alone is sufficient to perpetuate his memory, is the *Acta Eruditorum* of Leipzig, of which he was the first author, and in which he was engaged till his death. The first volume was published at Leipzig, in 4to, in 1682.

MENCKE (John Burchard), son to the preceding. After his studies he travelled into England and Holland; and upon his return was appointed professor of history at Leipzig in 1699. He gained great reputation by his lectures as well as his writings. He died in 1732, aged 58. He wrote many pieces. His *De Charlatanerid eruditorum declamationes duae*, is an excellent satire, designed to expose the artifices used by false scholars to raise themselves a name. As he named and pointed at certain persons, it exasperated them, and they procured his book to be seized; but it spread, and editions of it were multiplied. He likewise published *Methodes pour étudier l'Histoire, avec un catalogue des principaux historiens*, &c. He made a great many additions to Mr Lenglet's book, especially with regard to the German historians.

MENDICANTS, or BEGGING FRIARS, several orders of religious in Popish countries, who having no settled revenues, are supported by the charitable contributions they receive from others.

This sort of friars began in the 13th century. The Waldenses, who made profession of renouncing their estates, and leading a life of poverty, gave occasion to this institution. Two of that sect, Bernard and Durand of Olca, set up a congregation in the province of Tarragon, and called it *The Poor Catholics*. The same year, Dominick de Guzman, with nine more of his companions, founded the order of Preaching Friars, called from their founder *Dominick*.

*cans*. The other three Mendicant orders are, the *Franciscans*, *Augustines*, and *Carmelites*.

"A great many have embraced this severe order, (says Puffendorf), out of an opinion of a particular holiness and merit which they believed did belong to it, or rather an ecclesiastic ambition; the pride of mankind being so great and natural to some, that they did not think the commands of God sufficient, but would receive heaven rather as a desert than a gift, and were ambitious of having a preference before others even in another life."

Buchanan tells us, the Mendicants in Scotland, under an appearance of beggary, lived a very luxurious life; whence one wittily called them, not *Mendicants*, but *Manducant*, friars.

MENDOZA (Juan Gonzales de), an Augustan friar, of the province of Castile, was made ambassador from the king of Spain to the emperor of China. In 1593, he was made bishop of Liperi in Italy. In 1607 he was made bishop of Chiapa in New Spain, and the next year was removed to the see of Papean in the West Indies. He wrote a history of China in Spanish, which has been translated into several languages.

MENEGRATES, a physician of Syracuse, who flourished about 360 B. C. is famous for his skill in his profession, but much more for his vanity. He would always be followed by some of the patients whom he had cured, one dressed like Apollo, another like Esculapius, a third like Hercules, &c. As for himself, he would be called *Jupiter*. He wrote a letter to Philip the father of Alexander the Great, with this superscription, "Menecrates Jupiter to king Philip, Health." When that prince ridiculed him by replying, "Philip to Menecrates, Health and Good Sense." Menecrates composed a book of *Remedies*, which is lost.

MENEDEMUS, a Greek philosopher, born at Erythreum, was the son of Calisthenes, and one of Phedo's followers. He was in great esteem, and enjoyed several important posts in his own country. He several times defended Erythreum with great bravery, and died of grief when Antigonus became master of it. A person one day saying to him, "It is a great happiness to have what we desire," he replied, "It is a much greater to desire nothing but what we have." He flourished about 300 B. C.

MENELAUS, the son of Atreus, and the brother of Agamemnon, reigned at Sparta, when Paris deprived him of his wife Helen. This rape occasioned the famous war of Troy. See HELEN.

MENELAUS, a mathematician in the reign of the emperor Trajan, wrote three books on the *Sphere*, which have been published by father Merfenne.

MENES, born at This, a town of Thebais in Upper Egypt, was the founder of the Egyptian empire. He had three sons, viz. Athotis, who ruled after him at This and Thebes; Curudes, who, in Lower Egypt, founded the kingdom of Heliopoli, which afterward was the kingdom of Diospoli; and Necherophes, who reigned at Memphis. It is thought this Menes reigned 117 years after the birth of Phaleg, son of Heber, which was the very year of the dispersion of the people throughout the whole earth. In building Memphis, he stopped the Nile near it, by the invention of a  
MENE-

Meneſtrier caufeway 100 furlongs broad, and caufed it to run thro' the mountains.

**MENESTRIER** (John Baptiſt le), a native of Dijon, and one of the moſt learned and curious French antiquaries of his time, wrote, 1. A treatiſe on the medals, money, and ancient monuments of the Roman emperreſſes, in folio. 2. The moſt famous medals of the ancient Roman emperors and emperreſſes, in quarto. He died in 1634, aged 70.

**MENGRELIA**, a province of Turkey in Aſia. See **MINGRELIA**.

**MENIALS**, domeſtic or houſehold ſervants, who live under their lord or maſter's roof.

**MENINGES**, or **MENYNGES**, in anatomy, a name given to the dura and pia mater of the brain. See **ANATOMY**, n<sup>o</sup> 394.

**MENINX**, an iſland in the Mediterranean, to the weſt of the Syrtis Minor. Suppoſed by Strabo and Polybius to be Homer's country of the Lotophagi; and hence Ptolemy and Eratoſthenes denominate the iſland *Lotophagitis*, with a cognominal town *Meninx*. The country of Vibius Gallus the emperor, and of Voluſianus. Now called *Gerbi* and *Zarbi*.

**MENISPERMUM**, **MOONSEED**; a genus of the decandria order, belonging to the dioecia claſs of plants. There are three ſpecies, all of them climbing plants, riſing 14 feet high, and natives of warm climates; but noway remarkable for beauty. The ſeeds of a kind which grows in the Levant, being formed into a paſte, are regarded by the inhabitants as ſpecific againſt lice and cutaneous eruptions. The ſame paſte is likewiſe uſed for the purpoſe of intoxicating fiſhes.

**MENOCHIUS**, vulgarly **MEMOCIA**, (James), a famous lawyer, meanely born at Pavia, but who became fo ſkilful in the law, that he was called the *Baldus* and *Bartholus* of his age; all the princes of Italy ſoliciting him to their univerſities. He read at Padua 23 years together; and forlove of his country removed to Pavia, and ſucceeded Nicholas Gratiani. He hath got an immortal fame by his works, *De recuperanda poſſeſſione*; *De adipiſcenda poſſeſſione*; *De preſumtionibus*; *De arbitriis Judicium queſtionibus* & *cauſis conciliorum*, tom. 13. &c. He died in 1607, aged 75.

**MENNITH**, or **MINNITH**, Judges xi. 33. a town near Heſhbon, (Jerome), in Arabia Petraea; in a diſtrict named *Ecoſopolis*, or *twenty-towns*, (Cellarius). There is alſo a Minnith mentioned Ezekiel xxvii. as being in a good wheat country; but whether the ſame with the foregoing is uncertain; though ſome think, that the firſt Minnith lay in the country of Ammon, (Wells).

**MENNONITES**, a ſect of baptiſts in Holland, fo called from Mennon Simonis of Friezeland, who lived in the 16th century. This ſect believe, that the New Teſtament is the only rule of faith; that the terms *Perſon* and *Trinity* are not to be uſed in ſpeaking of the Father, Son, and Holy Ghoſt; that the firſt man was not created perfect; that it is unlawful to ſwear or to wage war upon any occaſion; that infants are not the proper ſubjects of baptiſm; and that miniſters of the goſpel ought to receive no ſalary. They all unite in pleading for toleration in religion, and debar none from their aſſemblies who led pious lives, and own the ſcriptures for the word of God. The

Mennonites meet privately; and every one in the aſſembly has the liberty to ſpeak, to expound the ſcriptures, to pray and ſing. They aſſemble twice every year, from all parts of Holland, at Rynſbourg, a village about two leagues from Leyden; at which time they receive the communion, fitting at a table, where the firſt diſtributes to the reſt; and all ſects are admitted, even the Roman Catholics, if they pleaſe to come.

**MENOLOGY**, the Greek calendar, in which the lives of the ſaints in ſhort, or barely their names, are cited; answering nearly to the **MARTYROLOGY** of the Latin church.

**MENSA**, in law-books, a term that includes in it all patrimony, and neceſſaries for livelihood.

**MENSALS**, **MENSALIA**, in church-hiſtory, ſuch livings as were formerly united to the tables of religious houſes, and hence called *menſal benefices*. See the article **BENEFICE**.

**MENSES**, **FLOORS**, *Courſes*, *Catamenia*, in medicine, the monthly evacuations from the uterus of women not with child and not giving fuck.

With regard to the cauſes of this evacuation, the beſt phyſiologiſts are entirely at a loſs. It was long diſputed whether the menſtral blood flowed from the uterus or vagina, but ſome obſervations of retroverted uteri have determined in favour of the former opinion.—For the diſorders which follow a ſuppreſſion, or too great a flow of the menſes, ſee **MEDICINE**, n<sup>o</sup> 488, 259—264. and p. 4871.

**MENSTRUUM**, in chemiſtry, any body which in a fluid or ſubtilized ſtate is capable of interpoſing its ſmall parts betwixt the ſmall parts of other bodies, ſo as to divide them ſubtilly, and form a new uniform compound of the two.

**MENSURATION**, in general, denotes the act or art of meaſuring lines, ſuperficies, or ſolids. See **GEOMETRY**.

**MENTHA**, **MINT**; a genus of the gymnoſperma order, belonging to the didynamia claſs of plants. There are many ſpecies; but not more than three are cultivated for uſe, namely, the *viridis* or common ſpearmint, the *piperita* or peppermint, and the *pulegium* or pennyroyal. All theſe are ſo well known as to need no deſcription; and all of them are very eaſily propagated by cuttings, parting the roots, or by offſets.

*Uſes*. For culinary purpoſes, the ſpearmint is preferable to the other two; but for medicine, the peppermint and pennyroyal have in ſome places almoſt entirely ſuperſeded it. A conſerve of the leaves is very grateful, and the diſtilled waters both ſimple and ſpirituous are univerſally thought pleaſant. The leaves are uſed in ſpring ſallads; and the juice of them boiled up with ſugar is formed into tablets. It has been imagined that cataplaſms and fomentations of mint, would diſſolve coagulations of milk in the breasts; but Dr Lewis ſays, that the curd of milk, digeſted in a ſtrong infuſion of mint, could not be perceived to be any otherwiſe affected than by common water: however, milk in which mint-leaves were ſet to macerate, did not coagulate near ſo ſoon as an equal quantity of the ſame milk kept by itſelf. Dr Lewis ſays, that dry mint digeſted in rectified ſpirits of wine, gives out a tincture, which appears by day-light of a fine dark green,

Mentha,  
Mentz.

green, but by candle-light of a bright red colour. The fact is, that a small quantity of this tincture is green either by day-light or by candle-light, but a large quantity of it seems impervious to common day-light; however, when held betwixt the eye and a candle, or betwixt the eye and the sun, it appears red.

The virtues of mint are those of a warm stomach and carminative: in loss of appetite, nausea, and continual reaching to vomit, there are few simples of equal efficacy. In colicky pains, the gripes to which children are subject, henteries, and other immoderate fluxes, this plant frequently does good service. It likewise proves beneficial in many hysterical cases, and affords an useful cordial in languors and other weaknesses consequent upon delivery. The best preparation in these cases is a strong infusion of the dried herb in water, (which is much superior to the green), or rather a tincture or extract prepared with rectified spirit. These possess the whole virtues of the mint; the essential oil and distilled water contain only the aromatic part; the expressed juice only the astringency and biteriflence, together with the mucilaginous substance common to all vegetables. The peppermint is much more pungent than the others.

Pennyroyal has the same general characters with the mint, but is more acrid and less agreeable when taken into the stomach. It has long been held in great esteem, and not undeservedly, as an aperient and deobstruent, particularly in hysterical complaints and suppressions of the menses. For these purposes the distilled water is generally made use of, or, what is of equal efficacy, an infusion of the leaves. It is observable, that both water and rectified spirit extract the virtues of this herb by infusion, and likewise elevate the greatest part of them by distillation. The expressed juice with a little sugar, is not a bad medicine in the chincoough.

MENTZ, an archbishopric and electorate in Germany. It lies on the banks of the river Mayne, between the electorate of Triers on the west, the Palatinate on the south, Franconia on the east, and the Wetteraw on the north. It is about 60 miles in length from north-east to south-west, and about 50 in breadth. A considerable part of the elector's revenue arises from the toll on the Rhine and the Mayne, and from the tax on the excellent wines produced in this country. The chief towns of any trade are, 1. Mentz, on the Rhine, near its confluence with the Mayne. This city claims a right to the invention of the art of printing, (see *History of PRINTING*.) Here is a very beautiful quay along the river, defended by several works well fortified with cannon. That part of the city which extends towards the river is most populous. The best vineyards for Rhenish wine being in this neighbourhood, Mentz has a flourishing trade in that commodity more particularly; and its commerce is the brisker, by reason that all the merchandize which passes up and down the Rhine stops in its harbour to change bottoms. In this neighbourhood is Hockhem, so celebrated for good wines, that the best Rhenish is from thence called *old hock*. 2. Bingen is a pleasant small town, which stands in the district called *Rhingaw*, which is so populous, that it looks like one entire town, intermixed with gardens and vineyards. The

rising grounds about it produce wines that are esteemed preferable to those of Baccharac, so much in vogue heretofore. 3. Elfeld, five miles west from Mentz, is a strong fortified town, on the north side of the Rhine, and the chief of the Rhingaw.—Here is Roderheim, a place noted for the growth of the best wines in these parts. 4. Weisbaden lies between six and seven leagues from Frankfort, and about five or six miles north of Mentz: it is the metropolis of a country belonging to the branch of Nassau-Saarbrack, and is famous for its mineral waters.

MENYANTHES, MARSH-TREFOIL, or *Buckbean*; a genus of the monogynia order, belonging to the pentandria class of plants. This plant grows wild in moist marshy places in many parts of Britain. It has three oval leaves standing together upon one pedicle, which issues from the root; their taste is very bitter, and somewhat nauseous. According to Mr Lightfoot, the flowers of this plant are so extremely beautiful, that nothing but their native soil could exclude it from a place in every garden. They grow in an elegant spike; are white, dashed with pink, and fringed internally with hairs. The highlanders esteem an infusion or tea of the leaves as good to strengthen the stomach. According to Mr Withering, an infusion of the leaves is prescribed in rheumatisms and dropsies; a dram of them in powder purges and vomits, and is sometimes given to destroy worms. In a scarcity of hops, the plant is used in the north of Europe to bitter the ale. The powdered roots are sometimes used in Lapland instead of bread, but they are unpalatable. Some people say, that sheep will eat it, and that it cures them of the rot; but from the Upsal Experiments it appears, that though goats eat it, sheep sometimes will not. Cows, horses, and swine, refuse it.—As to its medical virtues, Dr Lewis informs us, that it is an efficacious aperient and deobstruent; promotes the fluid secretions; and, if liberally taken, gently loosens the belly. It has of late gained great reputation in scorbutic and scrophulous disorders; and its good effects in those cases have been warranted by experience. Inveterate cutaneous diseases have been removed by an infusion of the leaves, drank to the quantity of a pint a-day, at proper intervals, and continued for some weeks. Boerhaave relates, that he was relieved of the gout by drinking the juice mixed with whey.

MENZINI (Benedict), a celebrated Italian poet, born at Florence, was professor of eloquence at the college Della Sapienza at Rome, where he died in 1704. He wrote, 1. The art of poetry. 2. Satires, elegies, hymns, and the Lamentations of Jeremiah. 3. *Academia Tusculana*, a work in verse and prose, which passes for his masterpiece.

MEOTIS, or PALUS MEOTIS, a sea of Turkey, which divides Europe from Asia; extending from Crim Tartary to the mouth of the river Don or Tanais.

MEPHITIC, a name expressing any kind of noxious vapour; but generally applied to that species of vapour called *fixed air*. See AIR, FIXED AIR, GAS, &c.

MERCATOR (Gerard), one of the most celebrated geographers of his time, was born at Ruremonde in 1512. He applied himself with such industry

Menyan-  
thes  
||  
Mercator.



Mercator,  
Merchant

dustry to geography and mathematics, that he is said to have frequently forgot to eat and drink. The emperor Charles V. had a particular esteem for him, and the duke of Juliers made him his cosmographer. He composed a chronology, some geographical tables, an Atlas, &c. engraving and colouring the maps himself. He died in 1594. His method of laying down charts is still used, and bears the name of *Mercator's charts*.

MERCATOR (Nicholas), an eminent mathematician in the 17th century, was born at Holstein in Denmark; and came to England about the time of the reformation, where he lived many years. He was fellow of the Royal Society; and endeavoured to reduce astronomy to rational principles, as appeared from a MS. of his in the possession of William Jones, Esq; He published several works, particularly *Cosmographia*. He gave the quadrature of the hyperbole by an infinite series; which was the first appearance in the learned world of a series of this sort drawn from the particular nature of the curve, and that in a manner very new and abstracted.

MERCATOR'S *Sailing*, that performed by Mercator's chart. See NAVIGATION.

MERCHANT, a person who buys and sells commodities in gross, or deals in exchanges; or that traffics in the way of commerce, either by importation or exportation. Formerly every one who was a buyer or seller in the retail way was called a *merchant*, as they still are both in France and Holland; but here shopkeepers, or those who attend fairs or markets, have lost that appellation.

Previous to a person's engaging in a general trade, and becoming an universal dealer, he ought to treasure up such a fund of useful knowledge, as will enable him to carry it on with ease to himself, and without risking such losses as great ill-concerted undertakings would naturally expose him to. A merchant should therefore be acquainted with the following parts of commercial learning. 1. He should write properly and correctly. 2. Understand all the rules of arithmetic that have any relation to commerce. 3. Know how to keep books of double and single entry, as journals, a ledger, &c. 4. Be expert in the forms of invoices, accounts of sales, policies of insurance, charter-parties, bills of lading, and bills of exchange. 5. Know the agreement between the money, weights and measures of all parts. 6. If he deals in silk, woollen, linnen, or hair manufactures, he ought to know the places where the different sorts of merchandizes are manufactured, in what manner they are made, what are the materials of which they are composed, and from whence they come, the preparations of these materials before working up, and the places to which they are sent after their fabrication. 7. He ought to know the lengths and breadths which silk, woollen, or hair-stuffs, linnen, cottons, suitians, &c. ought to have according to the several statutes and regulations of the places where they are manufactured, with their different prices, according to the times and seasons; and if he can add to his knowledge the different dyes and ingredients which form the various colours, it will not be useless. 8. If he confines his trade to that of oils, wines, &c. he ought to inform himself particularly of the appearances of the succeeding crops, in order to regulate his

disposing of what he has on hand; and to learn as exactly as he can, what they have produced when got in, for his direction in making the necessary purchases and engagements. 9. He ought to be acquainted with the sorts of merchandize found more in one country than another, those which are scarce, their different species and qualities, and the properest method for bringing them to a good market either by land or sea. 10. To know which are the merchandizes permitted or prohibited, as well on entering as going out of the kingdoms or states where they are made. 11. To be acquainted with the price of exchange, according to the course of different places, and what is the cause of its rise and fall. 12. To know the customs due on importation or exportation of merchandizes, according to the usage, the tariffs, and regulations, of the places to which he trades. 13. To know the best manner of folding up, embalming, or tonning, the merchandizes for their preservation. 14. To understand the price and condition of freighting and insuring ships and merchandize. 15. To be acquainted with the goodness and value of all necessaries for the construction and repairs of shipping, the different manner of their building; what the wood, the masts, cordage, cannons, sails, and all requisites, may cost. 16. To know the wages commonly given to the captains, officers, and sailors, and the manner of engaging with them. 17. He ought to understand the foreign languages, or at least as many of them as he can attain to; these may be reduced to four, viz. the Spanish, which is used not only in Spain, but on the coast of Africa, from the Canaries to the Cape of Good Hope: the Italian, which is understood on all the coasts of the Mediterranean, and in many parts of the Levant: the German, which is understood in almost all the northern countries; and the French, which is now become almost universally current. 18. He ought to be acquainted with the consular jurisdiction, with the laws, customs, and usages of the different countries he does or may trade to; and in general all the ordinances and regulations both at home and abroad that have any relation to commerce. 19. Though it is not necessary for a merchant to be very learned, it is proper that he should know something of history, particularly that of his own country; geography; hydrography, or the science of navigation; and that he be acquainted with the discoveries of the countries in which trade is established, in what manner it is settled, of the companies formed to support those establishments, and of the colonies they have sent out.

All these branches of knowledge are of great service to a merchant who carries on an extensive commerce; but if his trade and his views are more limited, his learning and knowledge may be too too: but a material requisite for forming a merchant is, his having on all occasions a strict regard to truth, and his avoiding fraud and deceit as corroding cankers that must inevitably destroy his reputation and fortune.

Trade is a thing of so universal a nature, that it is impossible for the laws of Britain, or of any other nation, to determine all the affairs relating to it: therefore all nations, as well as Great Britain, shew a particular regard to the *law-merchant*, which is a law made by the merchants among themselves: however, merchants and other strangers are subject to the laws

Merchant.

Merchet,  
Mercia.

of the country in which they reside. Foreign merchants are to sell their merchandise at the port where they land, in gross, and not by retail; and they are allowed to be paid in gold or silver bullion, in foreign coin or jewels, which may be exported. If a difference arises between the king and any foreign state, the merchants of that state are allowed six months time to sell their effects and leave the kingdom; during which time they are to remain free and unmolested in their persons and goods. See the articles *COMMERCE*, and *Mercantile Law*.

**MERCHET** (*MERCETUM*), a fine or composition paid by inferior tenants to the lord, for liberty to dispose of their daughters in marriage. No baron, or military tenant, could marry his sole daughter and heir, without such leave purchased from the king, *pro maritanda filia*. And many of our servile tenants could neither send their sons to school, nor give their daughters in marriage, without express leave from the superior lord. See *Kennet's Glossary in Maritajum*. See also *MARCHET*.

**MERCIA**, the name of one of the seven kingdoms founded in England by the Saxons. Though the latest formed, it was the largest of them all, and grew by degrees to be by far the most powerful. On the north it was bounded by the Humber and the Mersey, which separated it from the kingdom of Northumberland; on the east by the sea, and the territories of the East-Angles and Saxons; on the south by the river Thames; and on the west by the rivers Severn and Dee. It comprehended well nigh 17 of our modern counties, being equal in size to the province of Languedoc in France; very little, if at all, less than the kingdom of Arragon in Spain; and superior in size to that of Bohemia in Germany.

Penda is regarded as its first monarch; and the kingdom is thought to derive its name from the Saxon word *mere*, which signifies a *march*, *bound*, or *limit*, because the other kingdoms bordered upon it on every side; and not from the river Mersey, as some would persuade us. Penda assumed the regal title A. D. 626, and was of the age of 50 at the time of his accession; after which he reigned near 30 years. He was of a most furious and turbulent temper, breaking at different times with almost all his neighbours, calling in the Britons to his assistance, and shedding more Saxon blood than had been hitherto spilled in all their intestine quarrels. He killed two kings of Northumberland, three of the East-Angles, and compelled Kenwall king of the West-Saxons to quit his dominions. He was at length slain, with most of the princes of his family, and a multitude of his subjects, in a battle fought not far from the Leeds, by Ofwy king of Northumberland. This battle, which the Saxon chronicle tells us was fought at Winwidfield, A. D. 655, made a great change in the Saxon affairs, which the unbridled fury of Penda had thrown into great confusion. He had the year before killed Anna king of the East-Angles in battle, whose brother Ethelred notwithstanding took part with Penda. On the other hand, Penda the eldest son of Penda, to whom his father had given the ancient kingdom of the Mid-Angles, had two years before married the natural daughter of king Ofwy, and had been baptized at his court. At that time it should seem that Ofwy and Penda were

Mercia.

upon good terms; but after the latter had conquered the East-Angles, he resolved to turn his arms against the kingdom of Northumberland. Ofwy by no means had provoked this rupture; on the contrary, Bede tells us that he offered large sums of money, and jewels of great value, to purchase peace: these offers being rejected, he was reduced to the necessity of deciding the quarrel by the sword. The river near which the battle was fought overflowing, there were more drowned than killed. Amongst these, as the Saxon chronicle says, there were 30 princes of the royal line, some of whom bore the title of *kings*; and also Ethelred king of the East-Angles, who fought on the side of Penda against his family and country.

His son Peada, who married the daughter of that conqueror, became a Christian, and was not long after murdered as is said by the malice of his mother. His brother Wulfer becoming king of Mercia, embraced in process of time the faith of the Gospel, and proved a very victorious and potent monarch; and is, with no fewer than seven of his immediate successors, commonly styled *king of the Anglo-Saxons*, though none of them are owned in that quality by the Saxon chronicle. But though possibly none of them might enjoy this honour, they were undoubtedly very puissant princes, maintaining great wars, and obtaining many advantages over the sovereigns of other Saxon states, and especially the East-Angles, whom they reduced. The extent of the Mercian territories was so ample as to admit, and so situated as to require, the constituting subordinate rulers in several provinces; to whom, especially if they were of the royal line, they gave the title of *kings*; which occasions some confusion in their history. Besides the establishing episcopal sees and convents, the Saxon monarchs took other methods for improving and adorning their dominions; and as Mercia was the largest, so these methods were most conspicuous therein. Coventry, as being situated in the centre, was usually, but not always, the royal residence. Penda, who was almost continually in a state of war, lived as his military operations directed, in some great town on the frontiers. Wulfer built a castle or fortified palace for his own residence, which bore his name.—Offa kept his court at Sutton Walls near Hereford.

In each of the provinces there resided a chief magistrate; and if he was of the royal blood, had usually the title of *king*. Peada, at the time he married Ofwy's daughter, had the title of *king of Leicester*.—Ethelred made his brother Merowald king of Hereford; who, dying without issue, bequeathed it to his younger brother Mercelm. The like honours were sometimes conferred upon the princesses; and hence, in Mercia especially, we occasionally read of *vice-queens*. By these means the laws were better executed, the obedience of the subjects more effectually secured, and the splendor of these residences constantly kept up and augmented.

At length, the crown devolving sometimes on minors, and sometimes on weak princes, intestine factions also prevailing, the force of this hitherto mighty kingdom began feebly to decline. This falling out in the days of Egbert, the most prudent as well as the most potent monarch of the West-Saxons, he took advantage of these circumstances; and having en-

encouraged the East-Angles to make an attempt for the recovery of their independence, he, in a conjuncture every way favourable to his design, broke with the Mercians, and after a short war obliged them to submit. But this was not an absolute conquest, the kings of Mercia being allowed by him and his successors to retain their titles and dominions, till the invasion of the Danes put an end to their rule, when this kingdom had subsisted above 250 years; and when the Danes were afterwards expelled by the West-Saxons, it sunk into a province, or rather was divided into many.

MERCURIAL, something consisting of, or relating to, mercury.

MERCURIALIS (Jerom), an eminent Italian physician, born at Forli in 1530, where he first practised; but afterwards was professor of medicine successively at Padua, Bologna, and Pisa. His writings in physic are very numerous; besides giving an edition of Hippocrates in Greek and Latin, with notes, which, however, did not answer the expectations of the learned. He died in 1606; and in 1644 some select pieces of his were published at Venice in one volume folio.

MERCURIALIS, MERCURY; a genus of the encandria order, belonging to the diœcia class of plants. There are three species. 1. The annua, or French mercury, with spiked flowers, male and female. This is an annual plant, with a branching stalk about a foot high, garnished with spear-shaped leaves of a pale or yellowish green colour. The male plants have spikes of herbaceous flowers, growing on the top of the stalks: these fall off soon; but the female plants, which have testiculated flowers proceeding from the side of the stalks, are succeeded by seeds, which, if permitted to scatter, will produce plenty of plants of both sexes. 2. The perennis, mountain or dog's mercury, with spiked and testiculated flowers, grows under hedges and in woods, in many parts of Britain. This hath a perennial root, which creeps in the ground; the stalks are single, and without branches, rising ten or twelve inches high, garnished with rough leaves, placed by pairs at each joint, of a dark green colour, indented on their edges: these have their male flowers growing in spikes, upon different plants from those which produce seeds. 3. The tomentosa, or shrubby hairy mercury, is a native of the south of France, Spain, and Italy. It hath a shrubby branching stalk, growing a foot and an half high, garnished with oval leaves placed by pairs, and covered with a white down on both sides. The male flowers grow in short spikes from the side of the stalks upon different plants from the first. All the species are easily propagated by seeds, and are apt to become troublesome weeds where they have once got a footing.

*Properties.* The perennis, according to Mr Lightfoot, is of a soporific deleterious nature, noxious both to man and beast. There are instances of those who have eaten it by mistake instead of chenopodium, bonus Henricus, or English mercury, and have thereby slept their last. In the isle of Skye, it is called *Luglen-bracadale*; and an infusion of it is sometimes taken to bring on a salivation; but our author knows not how the experiment answers. Tournefort informs us, that the French make a syrup of the juice of the annua,

two ounces of which is given as a purge; and that they use it in pessaries and clysters, mixing one quantity of honey, to one and a half of the juice. Mr Withering differs greatly from Lightfoot concerning the qualities of the perennis. "This plant, (says he), dressed like spinach, is very good eating early in the spring, and is frequently gathered for that purpose; but it is said to be hurtful to sheep. Mr Ray relates the case of a man, his wife, and three children, who experienced highly deleterious effects from eating it fried with bacon; but this was probably when the spring was more advanced, and the plant become acrimonious. Steeped in water, it affords a fine deep blue colour. Sheep and goats eat it; cows and horses refuse it.

MERCURY, in natural history. See CHEMISTRY, n<sup>o</sup> 153, 205, 250, 214. See also METALLURGY, and QUICKSILVER.

The use of mercury in medicine seems to have been little known before the 15th century. The ancients looked upon it as a corrosive poison, though of itself perfectly void of acrimony, taste, and smell; there are examples of its having been lodged for years in cavities both of bones and fleshy parts, without its having injured or affected them. Taken into the body in its crude state, and undivided, it passes through the intestines unchanged, and has not been found to produce any considerable effect. It has indeed been recommended in asthma and disorders of the lungs; but the virtues attributed to it in these cases have not been warranted by experience.

Notwithstanding the mildness and inactivity of crude quicksilver undivided; when resolved by fire into the form of fume, or otherwise divided into very minute particles, and prevented from re-uniting by the interposition of proper substances, or combined with mineral acids, it has very powerful effects; affording the most violent poisons, and the most excellent remedies, that we are acquainted with.

The mercurial preparations, either given internally or introduced into the habit by external application, seem to liquify all the juices of the body, even those in the minutest and most remote vessels; and may be so managed as to promote excretion through all the emunctories. Hence their common use in inveterate chronic disorders proceeding from a thickens and sluggishness of the humours, and oblitinate obstructions of the excretory glands; in scrophulous and cutaneous diseases; and in the venereal lues. If their power is not restrained by proper additions to certain emunctories, they tend chiefly to affect the mouth; and, after having infused the juices in the remoter parts, occasion a plentiful evacuation of them from the salival glands.

The salutary effects of mercurials do not depend on the quantity of sensible evacuation. This medicine may be gradually introduced into the habit, so as, without occasioning any remarkable discharge, to be productive of very happy effects. To answer this purpose, it should be given in very small doses, in conjunction with such substances as determine its action to the kidneys or the pores of the skin. By this method inveterate cutaneous and venereal distempers have been cured, without any other sensible excretion than a gentle increase of perspiration or urine. Where there are ulcers in any part, they discharge for some time a very fetid matter, the quantity of which becomes gradually

Mercury. Iels, and at length the ulcer kindly heals. If the mercury should at any time, from cold or the like, affect the mouth, it may be restrained by omitting a dose, and, by warmth or suitable medicines, promoting the perspiration.

MERCURY, in the heathen mythology. See HERMES.

Molt of the actions and inventions of the Egyptian Mercury have likewise been ascribed to the Grecian, who was said to be the son of Jupiter and Maia, the daughter of Atlas. No one of all the heathen divinities had so many functions allotted to him as this god: he had constant employment both day and night, having been the common minister and messenger of the whole Pantheon; particularly of his father Jupiter, whom he served with indefatigable labour, and sometimes indeed in a capacity of no very honourable kind. Lucian is very pleasant upon the multitude of his avocations; and, according to the confession of the emperor Julian, Mercury was no hero, but rather one who inspired mankind with wit, learning, and the ornamental arts of life, than with courage. The pious emperor, however, omits some of his attributes; for this god was not only the patron of trade, but also of theft and fraud.

Amphion is said, by Pausanias, to have been the first that erected an altar to this god; who, in return, invested him with such extraordinary powers of music (and masonry), as to enable him to fortify the city of Thebes in Bœotia, by the mere sound of his lyre.

Horace gives us the best part of his character.

Thou god of wit, from Atlas sprung,  
Who by persuasive power of tongue,  
And graceful exercise, rein'd  
The savage race of human kind,  
Hail! winged messenger of Jove,  
And all th' immortal pow'r's above.  
Sweet parent of the bending lyre,  
Thy praise shall all thy friends inspire.  
Artful and cunning to conceal  
What'er in sportive theft you steal,  
When from the god who gilds the pole,  
E'en yet a boy, his herds you stole;  
With angry voice the threat'ning pow'r  
Bad thee thy fraudulent prey restore;  
But of his quiver too beguill'd,  
Pleas'd with the theft, Apollo smil'd.  
You were the wealthy Priam's guide,  
When safe from Agamemnon's pride,  
Through hostile camps, which round him spread  
Their watchful fires, his way he sped.  
Unspotted spirits you consign  
To blissful seats and joys divine;  
And, pow'rful, with thy golden wand,  
The light, unbodied crowd command:  
Thus grateful does thy office prove  
To gods below, and gods above.

Francis.

This ode contains the substance of a very long hymn to Mercury, attributed to Homer. Almost all the ancient poets relate the manner in which the Grecian Mercury discovered the lyre; and tell us that it was an instrument with seven strings; a circumstance which makes it essentially different from that said to have been invented by the Egyptian Mercury, which had but three. However, there have been many claimants besides Mercury to the seven-stringed lyre. See LYRE.

His most magnificent temple was on mount Cylene, in Arcadia. He is described by the poets as a fair beardless youth, with flaxen hair, lively blue eyes, and a smiling countenance. He has wings fixed to his cap

and sandals, and holds the caduceus (or staff surrounded with serpents with two wings on the top) in his hand; and is frequently represented with a purse, to show that he was the god of gain. The animals sacred to him, were the dog, the goat, and the cock. In all the sacrifices offered to him, the tongues of the victims were burnt; and those who escaped imminent danger, sacrificed to him a calf with milk and honey.

MERCURY, § in astronomy. See ASTRONOMY, n° 4, 20, 44, 108, 112.

MERCURY, in heraldry, a term used in blazoning by planets, for the purple colour used in the arms of sovereign princes.

MERCY-SEAT, in Jewish antiquity. See PROPITIATORY.

MERGANSEER. See MERGUS.

MERGUS, in ornithology, a genus of birds of the order of anseres; distinguished by having the beak of a cylindrical figure, and hooked at the extremities, and its denticulations of a fubulated form. There are six species.

1. The cucullatus, or crested diver of Catesby, has a globular crest, white on each side; and the body is brown above, and white below. It is a native of America. See Plate CLXXVI. fig. 4.

2. The merganser, or goosander, is a native of Europe. These birds frequent our rivers and other fresh waters, especially in hard winters; they are great divers, and live on fish. They are never seen in the southern parts of Great Britain during summer; when they retire far north to breed; for in that season they have been shot in the Hebrides. They are uncommonly rank, and scarce eatable. The male weighs four pounds: its length is two feet four inches; the breadth three feet two. The bill is three inches long, narrow, and finely toothed or serrated; the colour of that and of the irides is red. The *dark diver*, or female, is less than the male: the head and upper part of the neck is ferruginous; the throat white: the feathers on the hind part are long, and form a pendent crest: the back, the coverts of the wings, and the tail, are of a deep ashy-colour: the greater quill-feathers are black, the lesser white; the breast and middle of the belly are white, tinged with yellow.

3. The ferrator, or redbreasted merganser, weighs about two pounds: the length is one foot nine inches, the breadth two feet seven; the bill is three inches long; the lower mandible red; the upper dusky; the irides a purplish red: head and throat a fine changeable black and green: on the former a long pendent crest of the same colour; the tail short and brown; the legs orange-coloured. The head and upper part of the female are of a deep rufous-colour, and the tail ashy-coloured. These birds breed in the northern parts of Great Britain.

4. The cafter has a crested ashy-coloured head, a white throat, and a black bill and legs. It inhabits the south of Europe.

5. The albellus, or smew, weighs about 34 ounces: the length 18 inches, the breadth 26; the bill is near two inches long, and of a lead colour; the head is adorned with a long crest, white above, and black beneath: the head, neck, and whole under part of the body, are of a pure white; the tail is of a deep ashy-colour, the legs a bluish grey. The female, or *lough-diver*,

Mercury  
||  
Mergus.

*diver*, is less than the male: the back, the scapulars, and the tail are dusky; as, also the tail: the belly white.

6. The minotus, or headed smew, weighs about 15 ounces; the length one foot four inches, the breadth one foot eleven: the bill is of a lead colour; the head slightly crested, and of a rust colour: the hind part of the neck is of a deep grey, the forehead clouded with a lighter colour of the same kind: the back and tail are of a dusky ash-colour, the legs of a pale ash-colour.—It is a native of Europe.

MERIDIAN, in geography, a great circle supposed to be drawn through any part on the surface of the earth, and the two poles; and to which the sun is always perpendicular at noon.—In astronomy, the circle is supposed to be in the heavens, and exactly perpendicular to the terrestrial one.

MERIONETHSIRE, a county of North-Wales, on the south has the county of Cardigan, on the north those of Carnarvon and Denbigh, on the east those of Montgomery and Denbigh, and on the west the Irish sea. Its length is about 35 miles, its breadth 25, and its circumference 108, containing between 4 and 50,000 acres, 637 parishes, 3 towns, 26 rivers, and about 17000 inhabitants. The air of this county, which is more encumbered with mountains than any other in Wales, is exceeding sharp and bleak; and would be very unwholesome, if the vapours from the Irish sea were not in a great measure dispersed by the high winds to which this county is subject. The soil is very rocky and barren; except in the valleys, which yield good corn, and pasture for cattle and sheep. As the country is so mountainous, the inhabitants apply themselves chiefly to grazing, keeping vast flocks of sheep, deer, and goats, in the mountains, and living much upon butter, cheese, fowl, and fish, especially herrings. They have but little corn, and their black cattle are generally sold to the English. The chief rivers of the county are the Dyff or Towy, the Avon, the Drwrydh, and the Dee, which last runs through the lake called *Llyn Tigid* or *Pimble Meer*, without mixing its waters with those of the lake, as is supposed: for the salmon, with which the river abounds, are never taken out of the main stream; and the givineads, a fish peculiar to the lake, are never found in it. This lake is very large; and winds, it is pretended, will make it overflow, but land-floods never. The fish in the lakes, and the herbs on the rocks and mountains here, like those in Caernarvonshire and other hilly parts of Wales, are said to be much the same as those of the Alps. This county lies in the diocese of Bangor: it sends no member to parliament, except a knight of the shire; for it has no towns of any note.—Dr Campbell is of opinion that this county is capable of much improvement, if the inhabitants understood their own interest and were industrious.

MERIT, signifies desert. This term is more particularly applied to signify the moral goodness of the actions of men, and the rewards to which those actions entitle them.

MERLIN (Ambrose), a famous English poet, and reputed prophet, flourished at the end of the 5th century. Many surprising and ridiculous things are related of him. Several English authors have repre-

sented him as the son of an incubus, and as transporting from Ireland to England the great stones which form Stonehenge on Salisbury plain. Extravagant prophecies and other works are also attributed to him, on which some authors have written commentaries.

MERLIN, in ornithology. See FALCO.

MERLON, in fortification, is that part of a parapet which is terminated by two embrasures of a battery.

MERMAID, or MERMAN, a sea-creature frequently talked of, supposed half human and half a fish.

However naturalists may doubt of the reality of *mermen* or *mermaids*, we have testimony enough to establish it; though, how far these testimonies may be authentic, we cannot take upon us to say. In the year 1187, as Laray informs us, such a monster was fished up in the county of Suffolk, and kept by the governor for six months. It bore so near a conformity with man, that nothing seemed wanting to it but speech. One day it took the opportunity of making its escape; and, plunging into the sea, was never more heard of. *Hist. de Angleterre*, P. I. p. 403.

In the year 1430, after a huge tempest, which broke down the dikes in Holland, and made way for the sea into the meadows, &c. some girls of the town of Edam in West-Friesland, going in a boat to milk their cows, perceived a mermaid embarrassed in the mud, with a very little water. They took it into their boat, and brought it with them to Edam, dressed it in womens apparel, and taught it to spin. It fed like one of them, but could never be brought to offer at speech. Some time afterwards it was brought to Haerlem, where it lived for some years, though still showing an inclination to the water. Parival relates that they had given it some notion of a Deity, and that it made its reverences very devoutly whenever it passed by a crucifix. *Delices de Hollande*.

In the year 1560, near the island of Manar, on the western coast of the island of Ceylon, some fishermen brought up, at one draught of a net, seven mer men and maids; of which, several Jesuits, and among the rest F. Hen. Henriques, and Dimas Bosquez physicians to the viceroy of Goa, were witnesses. The physician, who examined them with a great deal of care, and made dissection thereof, asserts, that all the parts both internal and external were found perfectly conformable to those of men. See the *Hist. de la compagnie de Jesus*, P. II. T. IV. n.º 276, where the relation is given at length.

We have another account of a merman, near the great rock called *Diamond*, on the coast of Martinico. The persons who saw it, gave in a precise description of it before a notary. They affirmed that they saw it wipe its hand over its face, and even heard it blow its nose.

Another creature of the same species was caught in the Baltic in the year 1531, and sent as a present to Sigismund king of Poland, with whom it lived three days, and was seen by all the court. Another very young one was taken near Rocca de Sintra, as related by Damian Goes.

The king of Portugal and the grand master of the order of St James, are said to have had a suit at law to determine which party these monsters belong to.

In Pontopidan's Natural History of Norway, also,

Merns  
||  
Merle.

we have accounts of mermaids; but not more remarkable or any way better attested than the above.

MERNS, or KINCARDINSHIRE, a county of Scotland, stretching 27 miles in length, and 20 in breadth, is bounded on the east by the German ocean, on the south by the river of North Esk, on the west by Angus, and on the north by the river Dee and Aberdeenshire. The country is pretty plain and level, fruitful in corn and pasturage, producing an infinite number of fir-trees, besides a great number of agreeable plantations; and along the sea-coasts there are many convenient creeks and harbours.—The people are Lowlanders, civil, hospitable, and industrious.—The name *Merns* is by some derived from that of a valiant nobleman, who, subduing the country, received it in reward from Kenneth II. Cambden supposes it to retain part of the ancient name of *Vernicones*. The other name is derived from *Kincardin*, its ancient capital, now an inconsiderable village. The stocking-trade employs the natives from the banks of the Dee to Stone-hive; from thence to the Northesk they are wholly employed in weaving.

MEROE, (anc. geog.), an island of Ethiopia beyond Egypt, in the Nile; with a cognominal town, the metropolis of the Ethiopians. Here the shadow is said to decrease twice a-year, viz. when the sun is in the 18th degree of Taurus and in the 14th of Leo, (Pliny). Josephus says, that its ancient name was *Saba*; but changed to *Meroe* by Cambyfes, either after his sister or after his consort, who died there, (Strabo). All the ancients represent *Meroe* as an island, but in modern times it is a peninsula; to which greater credit is to be given, as more accurate than the ancient accounts.

MEROPS, in ornithology, a genus belonging to the order of picæ. The bill is crooked, flat, and carinated; the tongue is jagged at the point; and the feet are of the walking kind. There are six species, viz. 1. The apiafter, or bee-eater, has an iron-coloured back; the belly and tail are of a bluish green; and the throat is yellow. It inhabits the south of Europe. 2. The viridis, or Indian bee-eater, is green, with a black belt on the breast; and the throat and tail are black. 3. The congener is yellowish, with a green rump. It inhabits the south of Europe. 4. The superciliosus is green, with a white line both above and below the eyes, and a yellow throat. It is found in Madagascar. 5. The cinereus is variegated with red and yellow, with the two longest quill-feathers of the tail red. It is a native of America. 6. The cafer is grey, with a very long tail. It is a native of Ethiopia.

MERSE, a county of Scotland, called also *Berwickshire*. This last name it derives from the town of Berwick, which was the head of the shire before it fell into the hands of the English, and obtained the appellation of *Mers* or *March*, because it was one of the borders towards England. It is washed on the south and east by the river Tweed and the German Ocean, bounded on the west by Tweedale, and on the north by Lothian. It extends 24 miles from east to west, and the breadth amounts to 16. The face of the country is rough and irregular, exhibiting hills, moors, and moles, with intermediate valleys, which are pleasant and fruitful. It is watered by many streams; and

particularly by the famous Tweed, which, rising from the same hills that gave birth to the Clyde and Annan, runs with a rapid course thro' Tweedale Forest and Teviotdale, and after a course of 50 miles disembogues itself into the German Ocean. Notwithstanding the length of its course, it is not navigable above Berwick, where there is a noble bridge over it, consisting of 15 arches: there was another at Melrose, where nothing but the piers now remain. A third, of five arches, is maintained at Peebles; and a fourth has some time ago been built at Kelso. The shire of Berwick is generally distinguished into the three divisions of Mers, Lammermuir, and Lauderdale. The Mers is low, pleasant, and tolerably fruitful in corn. Lammermuir is a hilly country, abounding with game, and yielding good pasture for sheep and black cattle. Lauderdale is a tract of land lying on each side of the river Lauder, agreeably varied with hill, dale, and forest, producing good store of corn and pasturage, and giving the title of earl to the family of Maitland; but the most fruitful and populous parts of Berwickshire, are those that lie along the Tweed, and on both sides of the lesser rivers White Water, Black Water, and Eye. The feats of noblemen and gentlemen abound in this county. Berwick was the chief town until it fell into the hands of the English, and was annexed to their monarchy in the reign of King Edward IV. At present the principal town is Duns.

MERSENNE (Marin), in Latin *Mersennus*, a learned French author, born at Oysé, in the province of Maine, anno 588. He studied at La Flèche at the same time with Des Cartes; with whom he contracted a strict friendship, which lasted till death. He afterwards went to Paris, and studied at the Sorbonne, and in 1611 entered himself among the Minims. He became well skilled in Hebrew, philosophy, and Mathematics. He was of a tranquil, sincere, and engaging temper; and was universally esteemed by persons illustrious for their birth, their dignity, and their learning. He taught philosophy and divinity in the convent of Nevers, and at length became superior of that convent; but being willing to apply himself to study with more freedom, he resigned all the posts he enjoyed in his order, and travelled into Germany, Italy, and the Netherlands. He wrote a great number of excellent works; the principal of which are, 1. *Questions celeberrime in Genesim*. 2. *Harmonicorum libri*. 3. *De sonorum natura, causis, & effectibus*. 4. *Cogitata physico-mathematica*. 5. *La vérité des Sciences*. 6. *Les questions innouées*. He died at Paris in 1648. He had the reputation of being one of the best men of his age. No person was more curious in penetrating into the secrets of nature, and carrying all the arts and sciences to their utmost perfection. He was in a manner the centre of all the men of learning, by the mutual correspondence which he managed between them. He omitted no means to engage them to publish their works; and the world is obliged to him for several excellent discoveries, which, had it not been for him, would perhaps have been lost.

MERULA (George), an Italian of extraordinary parts and learning, born at Alexandria in the duchy of Milan about the year 1420. He taught youth at Venice and Milan for 40 years, and laboured abundantly

Mersenne,  
Merula.

Merula  
||  
Mefembry-  
anthemum.

ly in restoring and correcting ancient authors. He wrote, and addressed to Lewis Sforza, *Antiquitates Vicecomitum*; or "The actions of the Dukes of Milan," in 10 books; with some other things in the same way. His death, in 1494, is said not to have grieved any body; as he lived in a state of war with, and abused, almost all his contemporary scholars.

MERULA (Paul), born at Dord in Holland, a famous lawyer, historian, and linguist, was professor of history in the university of Leyden after Lipsius. He wrote, 1. Commentaries on Ennius. 2. The life of Erasmus and Junius. 3. A cosmography. 4. A treatise of law; and died in 1607.

MERUS, (anc. geog.), a mountain of the Hither India, hanging over the city Nyssa, built by Bacchus, and situated between the rivers Cophen and Indus. The name, denoting the thigh, gave rise to the fable of Bacchus being inserted into Jupiter's thigh, and being born twice; because in this mountain he and his army are said to have been preserved, when disease and pestilence raged in the plains below.

MERA-DE-ASTA, formerly a large town of Andalusia, seated on the river Guadaleta, between Arcos and Xeres de la Frontera; but now only a large heap of ruins. Here the Arabs conquered Roderick the last king of the Goths, and by that victory became masters of Spain in 713.

MESCHED, a considerable town of Persia, and in the province of Khorassan; fortified with several towers, and famous for the magnificent sepulchre of Iman Rifa, of the family of Ali, to whom the Persians pay great devotion. It is seated on a mountain near this town, in which are fine turquoise-stones; in E. Long. 59. 25. N. Lat. 37. 0.

MESEMBRYANTHEMUM, FIG-MARIGOLD; a genus of the pentagynia order, belonging to the pentandria class of plants. There are between 40 and 50 species; all African plants, from the Cape of Good Hope; near 40 of which are retained in our gardens for variety. Of these only one is annual, and the most remarkable of them all. It is called the *crystallium*, *diamond ficoides*, or *ice-plant*. It rises with a short, thick, succulent stalk, dividing low into many trailing, very spreading, succulent branches, bespangled all over with icy pimples; very pellucid and glittering; oval, undulate, alternate, papulose or pimply, glittering leaves; and from the sides of the branches, numerous, almost clofe fitting, white flowers, tinged with red or crimson; succeeded by plenty of feed in autumn. This singular and curious plant, being closely covered with large pellucid pimples, full of moisture shining brilliantly like diamonds, is in great esteem. It is a very tender plant while young; and is raised annually from feed by means of hot-beds. In June it will endure the open air till October, when it perishes; but if placed in a hot-house in autumn, it will often live all winter. It is commonly planted in pots for the convenience of removing from place to place; but if planted in the full ground, it grows considerably stronger, even to luxuriance: however, when confined in pots, it flowers more abundantly.

The other species are mostly durable in stem and foliage. Some are shrubby; others pendulous, with loose straggling stems, and branches inclining to the ground; while others have no stalks at all: their leaves

are universally very thick, succulent, fleshy; and of many various shapes, situations, and directions; while some are curiously punctured, or dotted with transparent points, and some have pellucid pimples, as already mentioned: they afford a very agreeable variety, at all times in the year, and merit a place in every collection. They are green-house plants, and are propagated by cuttings of their stalks and branches.

MESENTERY, in anatomy. See there, n<sup>o</sup> 355. MESENTERITIS, or *Inflammation of the MESSAGESRY*. See MEDICINE, n<sup>o</sup> 296.

MESOCOLON, in anatomy. See there, n<sup>o</sup> 355, c.

MESOLOGARITHMS, according to Kepler, are the logarithms of the co-fines and co-tangents; the former of which were called by Lord Napier *anti-logarithms*, and the latter *differentialis*.

MESOPOTAMIA, the ancient name of the province of DIARBECK, in Turkey in Asia. It is situated between the rivers Euphrates and Tigris; having Assyria on the east, Armenia on the north, Syria on the west, and Arabia Deserta with Babylonia on the south. In Scripture it is called *Padan Aram*.

MESOPTERYGIUS, in ichthyology, a term applied to such fishes as have only one back-fin; and that situated in the middle of the back.

MESPILUS, the MEDLAR; a genus of the pentagynia order, belonging to the icofandria class of plants. There are seven species, viz.

1. The Germanica, German mespilus, or common medlar, rises with a deformed tree-stem, branching irregularly 15 or 20 feet high; spear-shaped leaves, downy underneath; and large clofe-fitting, white flowers, singly from the sides of the branches; succeeded by large roundish brown fruit, the size of middling apples, which ripen in October, but are not eatable till beginning to decay. The varieties are, common great German medlar—smaller Nottingham medlar—pear-shaped Italian medlar. This species and varieties are all cultivated in the English gardens for the fruit: but the German or Dutch medlar, and the Nottingham kind, are the most common; and the latter of which two, though a smaller fruit, is rather preferable for richness and poignancy of flavour. These kinds of fruit are never eatable until they begin to rot; for when firm and sound, they are of a singularly austere disagreeable taste; yet having lain some time after being gathered, till they begin to assume a state of decay and become soft, they acquire a delicious flavour, extremely agreeable to many, though to others altogether unpalatable.

All the sorts ripen in the latter-end of October, or beginning of November; when being gathered, some should be laid in moist bran, in several layers, to forward their decay; others on straw in the fruitery: those in the bran will begin to be ready for use in about a fortnight, and those laid on straw will come gradually forward in succession.

2. The arbutifolia, arbutus-leaved mespilus, hath a shrubby stem, branching erectly five or six feet high; lanceolate, crenated, alternate leaves, downy underneath; and from the sides and ends of the branches, small white flowers in clusters; succeeded by small, roundish, purple fruit, like haws.

3. The amelanchier, or shrubby medlar, with black fruit, rises with several shrubby, slender, hairy stems, branching

Mesentery  
||  
Mespilus.

*Mespilus*. branching moderately about four feet high, having purplish branches; oval, serrated leaves, downy underneath; and small white flowers, in clusters at the ends of the branches; succeeded by small black fruit.

4. The chame-mespilus, or dwarf medlar, commonly called *basilard quince*, hath a shrubby, slender, smooth stem, branching weakly four or five feet high, having purplish branches; oval, serrated, smooth leaves, on long foot-stalks; and from the axillas, purple flowers, collected into round heads, with narrow, purplish, deciduous bractæ; succeeded by small red fruit.

5. The cotoneaster, commonly called *dwarf quince*, rises with a shrubby, smooth stem, branching four or five feet high, the branches slender and reddish; oval entire leaves on short foot-stalks; and from the axillas, small close-fitting purple flowers, two or three together; succeeded by small, roundish, bright-red fruit.

6. The *Canadensis*, Canada snowy mespilus, hath a shrubby, smooth stem, branching four or five feet high, with smooth, purplish branches; oval-oblong, serrated, smooth leaves, on long footstalks; and all the branches terminated by clusters of snowy-white flowers; succeeded by small, purplish fruit, like haws.

3. The *pyracantha*, or ever-green thorn, rises with a shrubby, spinous stem, branching diffusely 12 or 14 feet high, the branches slender and flexible, with a dark-greenish bark, armed with long sharp spines; spear-shaped-oval, crenated, ever-green leaves; and all the shoots terminated by numerous clusters of whitish flowers; succeeded by large bunches of beautiful red berries, remaining all winter, and exhibiting a very ornamental appearance.

All these seven species of mespilus are of the tree and shrub kind; the first six sorts are deciduous, the seventh an ever-green: the leaves are universally simple; those of the mespilus *Germanica* very large, the others mostly of moderate size, and which in most of the sorts grow upon short foot-stalks. They all flower abundantly every summer, the flowers universally hermaphrodite, and consisting each of five large roundish petals, 20 stamina, and five styles. They are all very hardy, and succeed in any common soil and situation, and their propagation and culture is very easy.

The first sort and varieties are cultivated as fruit-trees, principally as standards, sometimes also as espaliers for variety. The other species are very proper furniture for any ornamental plantation, where they will make an agreeable variety with their different foliage; and their flowers make a fine appearance, as also their fruit in autumn and winter, which, if not devoured by birds, remain long on the branches, and afford a fine variety in those seasons. The *pyracantha*, being rather of flexible growth, is most commonly trained against walls or the fronts of houses, both for the support of its flexible branches, and that it may exhibit its berries more ornamentally.

When it is designed to have any of the common medlars as fruit-trees, they may be trained either as dwarfs, for dwarf standards, or for espaliers, or trained as half or full standards; and managed in either of those modes of training nearly as other fruit-trees, particularly the apple and pear; and are raised either by seed, by grafting, or by budding, but either of the two latter methods are the most certain for continuing the sorts without variation: observing, after shortening their

first shoots from the graft or bud, where it shall seem necessary to force out a proper supply of wood to form a head, to train the branches afterwards principally at full length, and let the standards branch out in their own way.

MESS, in a military sense, implies a number of soldiers, who, by laying away a certain proportion of their pay towards provisions, mess together: six or eight is generally the number of each mess. Experience proves, that nothing contributes more to the health of a soldier, than a regular and well-chosen diet, and his being obliged every day to boil the pot: it corrects drunkenness, and in a great measure prevents gaming, and thereby desertion.

MESSANA, (anc. geog.), the first town of Sicily on crossing over from Italy, situate on the strait now called the *Faro*, (Italicus). Anciently called *Zancla*, according to Diodorus Siculus, from king Zanclus; or, according to others, from the Sicilian term *Zanclon*, denoting a sickle, alluding to the curvity of the coast: a name appropriated by the poets; and hence *Zanclæi*, the people, (Herodotus, Paufanias). The other name *Messana* is from the *Messenii* of Peloponnesus, (Strabo). Thucydides ascribes its origin to Anaxilas the Messenian, tyrant of Rhegium, who received all comers, calling the town after the name of his country. The Greeks always call it *Messene*; the Romans *Messana* constantly, to distinguish it from *Messene* of Peloponnesus. Now *MESSINA*.

MESSENA, or MESSENE, an inland town, and the capital of Messenia, a country of Peloponnesus; erroneously placed by Ptolemy on the coast. It was built by Epaminondas, who recalled all the Messenian exiles, and gave the town the name of *Messene*. A place vying in point of strength and situation with Corinth, according to Strabo; and therefore Demetrius Phariar advised Philip, father of Perseus, that if he wanted to have Peloponnesus in his power, he should make himself master of these two towns, as thus he would have the ox by both horns.

MESSENA, a country in the south of Peloponnesus, mostly maritime, situate between Elea to the west, and Laconica to the east. Anciently a part of Laconica under Menelaus, and called *Messene* by Homer; interpreted by the scholiast, *Messeneæ Regiæ*. *Messenii*, the people, reduced to a state of slavery and subjection by the Spartans; *Messenius*, the epithet.

This country is famous in history, on account of the resistance made by the Messenians against the Spartans, and the exploits of their hero Aristomenes. The first hostilities commenced about the year 652 B. C. on what occasion is uncertain. Though the Messenians were inferior in the knowledge of the art of war to the Spartans; yet, by keeping for some time on the defensive, they improved so much, that in three years time they found themselves in a capacity of giving battle to their enemies in the open field; nor did they appear to be in any degree inferior either in courage or conduct: the war was therefore protracted, with various success, on both sides. At last, both consulted the oracle at Delphi; and received for answer, "that whoever should first dedicate 100 tripods in the temple of Jupiter at Ithome, a strong-hold of the Messenians, should be masters of the

Mess  
Messenian.



Messenia. the country." The inhabitants of Messenia, on hearing this, having no money to make the tripods of brass, fell to cutting them out in wood; but before this could be accomplished, a Spartan having got into the city by stratagem, dedicated 100 little tripods of clay: which threw the Messenians into such despair, that they at last submitted to the Spartans.

The new subjects of Sparta were treated with the utmost barbarity by these cruel tyrants; so that in 685 B. C. a new war commenced under Aristomenes, a man of unconquerable valour, and enthusiastically fond of liberty. He perceived that the Argives and Arcadians, who were called the *allies* of the Lacedæmonians, adhered to them only through fear of their power; but that in reality they hated them, and wished to revenge the injuries they had done them. To these Aristomenes applied; and receiving an answer conformable to his wishes, he engaged his countrymen unanimously to take up arms. About a year after the revolt began, and before either party had received any auxiliaries, the Spartans and Messenians met at a village called *Dera*, where an obstinate engagement ensued. Aristomenes was conceived to have performed more than mortal achievements: in gratitude therefore, respect being also had to his royal descent, his countrymen unanimously saluted him *king*; which title he modestly waved, alleging, that he took up arms to set them free, and not to make himself great: he contented, however, to accept the title of *general*, with a power of doing whatsoever he thought requisite for the service of the public. Knowing well the superstition of the age in which he lived, he resolved to intimidate the Spartans, by showing them what he was sure they would take for an ill omen. Disguising himself therefore, he went privately to the city, where, in the night, he hung up a shield on the wall of the temple of Minerva, with this inscription: *Aristomenes dedicates this, out of the spoils of the Spartans, to the goddess*. It was easily perceived that this war would be both long and bloody; the Lacedæmonians therefore sent deputies to Delphi, to inquire of the oracle concerning its event: the answer they received was, *That it behoved the Spartans to seek a leader from Athens*. The Athenians, naturally envious of the Spartans, granted their request indeed, but in such a manner as manifested their spite; for they sent them for a general Tyræus, a schoolmaster and poet, lame of one foot, and who was suspected to be a little out of his wits. But here their skill failed them; for this captain, notwithstanding his despicable appearance, proved of great consequence to Sparta, teaching them how to use good, and how to bear up under evil fortune.

In the mean time, Aristomenes had drawn together a mighty army, the Eleans, Argives, Sicyonians, and Arcadians, having sent troops to his assistance; the Spartans in this, as in the former war, having no ally but Corinth. The Spartan kings, according to the custom of their city, no sooner took the field, than, notwithstanding their inferiority in number, they offered the enemy battle, which Aristomenes readily accepted.—It was long, obstinate, and bloody; but in the end the Messenians were victorious, and the Lacedæmonians put to flight, with a great slaughter. It is scarce to be conceived how much the Spartans were

struck with this defeat: they grew weary of the war, dissatisfied with their kings, dissident of their own power, and, in a word, sunk into a state of general uneasiness and want of spirit. It was now that the Athenian general convinced them, that he was capable of fulfilling all the promises of the oracle; he encouraged them by his poems, directed them by his counsels, and recruited their broken armies with chosen men from among the Helotes. Aristomenes, on the other hand, acted with no less prudence and vigour. He thought it not enough to restore the reputation of the Messenians, if he did not also restore their wealth and power: he therefore taught them to act offensively against their enemies; and, entering the territories of Sparta, he took and plundered Phæze, a considerable borough in Laconia, putting all such as made any resistance to the sword, carrying off at the same time an immense booty. This, however, was an injury which the Spartans could not brook with patience; they therefore sent immediately a body of forces to overtake the Messenians, which accordingly they did: but Aristomenes routed these pursuers, and continued to make a mighty slaughter of them, till such time as he was disabled by having a spear thrust in his side, which occasioned his being carried out of the battle. His cure, which took up some time, being finished, he resolved to carry the war even to the gates of Sparta; and to that purpose raised a very great army: but, whether he found his design impracticable, or was really diverted by some dream, he gave out, that Castor and Pollux, with their sister Helena, had appeared to him, and commanded him to desist. A short time after this retreat, going with a small party to make an incursion, and attempting to take prisoners some women who were celebrating religious rites near Egila, a village in Laconia, those zealous matrons fell upon him and his soldiers with such fury, that they put them to flight, and took him prisoner: however, he soon afterwards made his escape, and rejoined his forces. In the third year of the war, the Spartans, with a great force, entered Messenia, whither Aristocrates king of Arcadia was come, with a great body of troops, to the assistance of his allies: Aristomenes therefore made no difficulty of fighting when the Spartans approached; but they entering privately into a negotiation with Aristocrates, engaged him with bribes and promises to betray his confederates. When the battle began, the deceitful Arcadian represented to the forces under his command, the mighty danger they were in, and the great difficulty there would be of retreating into their own country, in case the battle should be lost: he then pretended, that the sacrifices were ominous; and, having terrified his Arcadians into the disposition of mind fittest to serve his purpose, he not only drew them off from both wings, but, in his flight, forced through the Messenian ranks, and put them too in confusion. Aristomenes and his troops, however, drew themselves into close order, that they might defend themselves the best they could: and indeed they had need of all their valour and skill; for the Lacedæmonians, who expected this event, immediately attacked and surrounded them on all sides. Fortune was, on this occasion, too powerful either for the courage or the conduct of the Messenians; so that, notwithstand-

Messenia.

Messenia ing their utmost efforts, most of their army were cut to pieces, and, amongst them, the chief of their nobility. Aristomenes, with the poor remains of his shattered forces, retired as well as he could; and, perceiving that it was now impossible to maintain the war against the Lacedæmonians upon equal terms, he exhorted his countrymen to fortify mount Era, and to make the best dispositions possible for a long defence. He likewise placed garrisons in Pylus and Methone on the sea-coasts; and to these three places he gathered all the inhabitants, leaving the rest of Messenia to the mercy of the Spartans. They, on the other hand, looked on the war as now in a manner finished; for which reason they divided the lands among their citizens, and caused them to be carefully cultivated, while they besieged Era. But Aristomenes quickly convinced them that the war was far from being over: he chose out of all the Messenians 300 men, with whom he ravaged all the adjacent country; carried off a prodigious booty; and, when Messenia could no longer supply the wants of his garrison, penetrated into Laconia, and bore away corn, wine, cattle, and whatever else was necessary to the subsistence of his countrymen shut up in Era: so that at last the Spartans were constrained to issue a proclamation, forbidding the cultivation, not only of the Messenian territory in their hands, but also of Laconia in its vicinity; whereby they distressed themselves more than their enemies, inducing at last a famine in Sparta itself, which brought with it its usual attendant, sedition. Here again all things had gone wrong, if the wisdom of the poet Tyrtæus had not supported the Spartan courage; nor was it without much difficulty that he influenced them to continue the blockade of Era, and to maintain a flying camp for the security of the country.

Aristomenes, in spite of all these precautions, committed terrible depredations with his small corps of 300 men. Amongst other places which he plundered, the city of Amyclæ was one; from whence he carried not only a great quantity of riches, but also many carriages laden with provisions. The kings of Sparta lying with their troops in its neighbourhood, as soon as they heard of this expedition, marched after Aristomenes with the utmost diligence; and, as the Messenians were incumbered with their booty, came up with them before he could reach Era. In this situation of things, Aristomenes, prompted rather by despair than prudence, disposed his troops in order of battle; and, notwithstanding they were few, made a long and vigorous resistance against the whole Lacedæmonian army. At length, however, numbers prevailed: the greatest part of the Messenians were slain on the spot; and Aristomenes, with about 50 of his men who survived the slaughter, were taken prisoners; that chief having received so many wounds, that he was senseless when they carried him away. The Lacedæmonians expressed the loudest joy at the sight of this illustrious captive; who, for so many years, by his single abilities, had enabled his exhausted country to defend itself against the whole force of Sparta. When he was recovered of his wounds, they decreed him and all his fellow-prisoners to be thrown together into a deep cavern, which was the common punishment of the lowest kind of offenders. This judgment was executed with the utmost severity,

Messenia expecting that Aristomenes had leave to put on his armour. Three days he continued in this dismal place, lying upon, and covered over with, dead bodies. The third day, he was almost famished through want of food, and almost poisoned with the stench of corrupted carcases, when he heard a fox gnawing a body near him. Upon this he uncovered his face, and perceiving the fox just by him, he with one hand seized one of its hind-legs, and with the other defended his face, by catching hold of its jaw when it attempted to bite him. Following as well as he could his straggling guide, the fox at last thrust his head into a little hole; and Aristomenes then letting go his leg, he soon forced his way through, and opened a passage to the welcome rays of light, from which the noble Messenian had been so long debarred. Feeble as he was, Aristomenes wrought himself an outlet with his nails; and travelling by night with all the expedition he could, at length arrived safe at Era, to the great joy and amazement of his countrymen. When this news was first blazed abroad, the Spartans would have had it pass for a fiction; but Aristomenes soon put the truth of it out of doubt, by falling on the posts of the Corinthians, who, as allies of the Spartans, had a considerable body of troops before Era. Most of their officers, with a multitude of private men, he slew; pillaged their camp; and, in short, did so much mischief, that the Spartans, under the pretence of an approaching festival, agreed to a cessation of arms for 40 days, that they might have time to bury their dead. On this occasion, Aristomenes for the second time celebrated the *hecatomphonia*, or the sacrifice appointed for those who had killed 100 of the enemy with their own hands. He had performed the same before and after his second battle; and he lived to do it a third time: which must appear wonderful to the reader, when he is informed, that, notwithstanding this truce, certain Cretan archers in the service of the Spartans, seized Aristomenes as he was walking without the walls, and carried him away a prisoner. There were nine of them in all; two of them immediately slew with the news to Sparta, and seven remained to guard their prize, whom they bound, and conducted to a lone cottage inhabited only by a widow and her daughter. It so fell out, that the young woman dreamt the night before, that she saw a lion without claws, bound, and dragged along by wolves; and that she having loosed his bonds, and given him claws, he immediately tore the wolves to pieces. As soon as Aristomenes came into the cottage, and her mother, who knew him, had told her who he was, she instantly concluded that her dream was fulfilled; and therefore plied the Cretans with drink, and, when they were asleep, took a poniard from one of them, cut the thongs with which Aristomenes was bound, and then put it into his hands. He presently verified her vision, by putting all his guards to death; and then carried her and her mother to Era, where, as a reward for her service, he married the young woman to his son Gorgus, then about 18 years of age.

When Era had held out near eleven years, it fell into the hands of Sparta by an accident: the servant of one Empiramus, a Spartan commander, driving his master's cattle to drink at the river Neda, met frequently with the wife of a Messenian, whom he engaged

Messenia. engaged in an amour. This woman gave him notice, that her husband's house was without the wall; so that he could come to it without danger, when the good man was abroad; and she likewise gave him intelligence when her husband was upon duty in the garrison. The Spartan failed not to come at the time appointed; but they had not been long in bed before the husband returned, which put the house into great confusion: the woman, however, secured her gallant; and then let in her husband, whom she received, in appearance, with great joy, inquiring again and again by what excess of good fortune she was blessed with his return. The innocent Messenian told her, that Aristomenes being detained in his bed by a wound, the soldiers, knowing that he could not walk the rounds, had a grant to retire to their houses, to avoid the inclemency of the season. The Spartan no sooner heard this, than he crept softly out of doors, and hastened away to carry the news to his master. It so happened, that the kings were at this time absent from the camp, and Empiramus had the chief command of the army. As soon as he received this information, he ordered his army to begin its march, though it rained excessively, and there was no moon-light. The fellow guided them to the ford, and managed matters so well that they seized all the Messenian posts: yet, after all, they were afraid to engage; darkness, an high wind, heavy rain, together with the dread of Aristomenes, keeping them quiet in the places they had seized. As soon as it was light, the attack began; and Era had been quickly taken, if only the men had defended it; but the women fought with such fury, and, by their mingling in the fray, brought such an accession of numbers, as made the event doubtful. Three days and two nights this desperate engagement lasted: at last, all hopes of preserving the city being lost, Aristomenes drew off his wearied troops. Early the fourth morning, he disposed the women and children in the centre, the Messenian youth in the front and rear, the less able men in the main body: himself commanded the van; the rear-guard was brought up by Gorgus and Manticlus, the former the son of Aristomenes, the latter of Theocles, a Messenian of great merit, who fell with much glory in this attack, fighting valiantly in the cause of his country. When all things were ready, Aristomenes caused the last barrier to be thrown open; and, brandishing his spear, marched directly towards the Spartan troops, in order to force a passage. Empiramus, perceiving his intent, ordered his men to open to the right and left, and fairly gave them a passage; so that Aristomenes marched off in triumph, as it were, to Arcadia.

The Arcadians, when they heard that Era was taken, were very desirous of succouring their old confederates in this deep distress: they therefore in-treated their king Aristocrates to lead them into Messenia. But he, corrupted by the Lacedæmonians, persuaded them that it was too late; that the Messenians were all cut off; and that such a step would only expose them to the fury of the conquerors. When the thing appeared to be otherwise, and it was known that Aristomenes was on the frontiers of Arcadia, they went in crowds to carry him provisions, and to testify their readiness to afford him and those under

his command all the assistance in their power. Aristomenes desired to be heard before a general assembly; which being accordingly convoked, he there opened one of the boldest and best-laid schemes recorded in history: he said, that he had yet 500 undaunted soldiers, who, at his command, would undertake any thing; that it was very probable most of the Spartans were employed in pillaging Era, and that therefore he determined to march and surprize Sparta; which appeared so sensible, that all the assembly loudly commended his great capacity and unshaken courage. Aristocrates, however, took care to betray him; having, by various pretences, retarded the execution of the project. The Arcadians, who began to suspect him, waited for and surprized the messengers as they came back. They took the letters from him, and read them openly in the assembly. The purport of them was, that they acknowledged his great kindness both now and in the battle; and promised, that the Lacedæmonians would be grateful. As soon as the letters were read, the Arcadians fell to flouting their king, frequently calling upon the Messenians to assist them; which, however, they did not, waiting for Aristomenes's orders; who, far from triumphing in this spectacle, stood still, with his eyes fixed on the ground, which he wet with his tears, his soul pierced with sorrow to see a crowned head so shamefully and so deservedly put to death. The Arcadians afterwards erected a monument over him, with an inscription to perpetuate his infamy. As for the Messenians under the command of Gorgus and Manticlus, they passed over into Sicily; where they founded the city of Messene, one of the most famous in the island. Aristomenes remained, however, in Greece; where he married all his daughters, except the youngest, to persons of great rank. A prince of Rhodes, inquiring of the oracle at Delphi whom he should espouse, that his subjects might be happy under his posterity, was directed to marry the daughter of the most worthy of the Greeks; which answer was immediately understood to point at the virgin daughter of Aristomenes. Her therefore he demanded, and received; Aristomenes accompanying him back to his dominions, where he formed a scheme of uniting the Lydians and Medes against the Spartans, resolving, with this view, to go into Media, and to the court of Sardis: but while he meditated these great things, death surprized him, and thereby freed Lacedæmon from the most formidable enemy he ever had.

MESSENGERS, are certain officers chiefly employed under the direction of the secretaries of state, and always in readiness to be sent with all kinds of dispatches foreign and domestic. They also, by virtue of the secretaries warrants, take up persons for high treason, or other offences against the state. The prisoners they apprehend are usually kept at their own houses, for each of which they are allowed 6s. 8d. per day, by the government: and when they are sent abroad, they have a stated allowance for their journey, viz. 30l. for going to Paris, Edinburgh, or Dublin; 25l. for going to Holland, and to other places in the same proportion; part of which money is advanced for the expence of their journey. Their standing salary is 45l. per annum; and their posts, if purchased, are esteemed worth 300l. The messengers wait 20

Messenia,  
Messengers.

Messengers, at a time, monthly, and are distributed as follows, viz. four at court, five at one secretary's office, five at another, two at the third for North Britain, three at the council-office, and one at the lord chamberlain's of the household.

MESSENGERS, in Scotland. See LAW, n° clviii. 16.

MESSENGERS of the *Exchequer*, are four officers who attend the exchequer, in the nature of pursuivants, and carry the lord treasurer's letters, precepts, &c.

MESSANGER of the *Press*, a person who, by order of the court, searches printing-houses, bookfellers shops, &c. in order to discover the printers or publishers of seditious books, pamphlets, &c.

MESSIAH, a word signifying one *anointed*, or installed into an office by unction. It was usual among the Jews to anoint kings, high-priests, and sometimes prophets, at the designation or installment of them, to signify emblematically the mental qualifications necessary for discharging these offices. Saul, David, Solomon, and Joash, kings of Judah, received the royal unction. Aaron and his sons received the sacerdotal, and Elisha the disciple of Elijah received the prophetic, unction.—The name MESSIAH, *Anointed*, or *Christ* (*Χριστος*), was given to the kings and high-priests of the Jews. The patriarchs and prophets are also called by the name of *Messiahs* or the *Lord's anointed*. See 1 Sam. xii. 3, 5. 1 Chron. xvi. 22. Pl. cv. 15.

But this name MESSIAH was principally and by way of eminence given by the Jews to their expected great Deliverer, whose coming they still vainly wait; and is a name the Christians apply to JESUS CHRIST, in whom the prophecies relating to the Messiah were accomplished. The sum of these prophecies is, That there should be a glorious person, named *Messiah*, descended from Abraham, Isaac, and Jacob, who should be born at Bethlehem, of a virgin of the family of David, then in its decline, before the Jews ceased to be a people, while the second temple was standing, and about 500 years after Ezra's time; who, though appearing in mean circumstances, should be introduced by a remarkable forerunner, whose business it should be to awaken the attention and expectation of the people. That this illustrious person called *Messiah*, should himself be eminent for the piety, wisdom, and benevolence of his character, and the miraculous works he should perform: yet that, not-

withstanding all this, he should be rejected and put to death by the Jews; but should afterwards be raised from the dead, and exalted to a glorious throne, on which he should through all generations continue to rule, at the same time making intercession for sinners. That great calamities should for the present be brought on the Jews for rejecting him: whereas the kingdom of God should by his means be erected among the Gentiles, and disperse itself even unto the ends of the earth; wherever it came, destroying idolatry, and establishing true religion and righteousness. In a word, That this glorious Person should be regarded by all who believed in him, as a divine teacher, an atoning sacrifice, and a royal governor: by means of whom God would make a covenant with his people, very different from that made with Israel of old; in consequence of which they should be restored, and established in, the divine favour, and fixed in a state of perpetual happiness. See JESUS CHRIST, and CHRISTIANITY.

MESSUAGE, MESSUAGIUM, in law, a dwelling-house, with some land adjoining assigned for its use. By the name of *messuage* may a garden, shop, mill, cottage, chamber, cellar, or the like, pass.—In Scotland, *messuage* denotes what is called in England the *manor-house*; viz. the principal dwelling-house within any barony.

METACARPUS, in anatomy. See there, n° 54. METALEPSIS. See ORATORY, n° 59.

METALLIZATION, the natural process by which metals are formed in the bowels of the earth. See METALLURGY, sect. i.

METALS. See METALLURGY; and CHEMISTRY, n° 43, 140, 192, 236, 278, 332, 348.

METAL, in heraldry. There are two metals used in heraldry, by way of colours, viz. gold and silver, in blazon called *or* and *argent*.

In the common painting of arms these metals are represented by white and yellow, which are the natural colours of those metals. In engraving, gold is expressed by dotting the coat, &c. all over; and silver, by leaving it quite blank.

It is a general rule in heraldry, never to place metal upon metal, nor colour upon colour: so that if the field be of one of the metals, the bearing must be of some colour; and if the field be of any colour, the bearing must be of one of the metals.

## M E T A L L U R G Y.

METALLURGY, according to Boerhaave, comprehends the whole art of working metals, from the glebe or ore, to the utensil; in which sense, *essay*, *smelting*, *refining*, *parting*, *smithery*, *gilding*, &c. are only branches of metallurgy. But, in the present work, *Gilding*, *Parting*, *Purifying*, *Refining*, *Smithery*, &c. are treated under their proper names. With others, therefore, we have chosen to restrain *Metallurgy* to those operations required to separate metals from their ores for the uses of life. These operations are of two kinds: the smaller, or *Assaying*; and the larger, or *Smelting*. But a particular descrip-

tion of the ores themselves seemed likewise necessary to be given; and to this place, too, we have referred a general account of metals, metallization, mines, and ores, as a proper introduction to the subject. Hence the following division into three parts. The *first* treating, 1. Of metals and metallization. 2. Of mines and ores in general. 3. Of the pyrites. 4. Of the assaying of ores in general. The *second*, Of the particular ores, and the methods of assaying them. The *third*, Of smelting of ores, or the methods of extracting metals from large quantities of ores for the purposes of commerce or manufacture.

Messuage  
||  
Metals.

P A R T I.

SECT. I. *Of Metals and Metallization.*

UNDER the general name *metal*, we comprehend here not only the metals properly so called, but also the *femimetalis*, or all matters which have the essential metallic properties, which we shall here recount. Thus the word *metal* and *metallic substance* will be synonymous in this article.

Metallic substances form a class of bodies, not very numerous, of very great importance in chemistry, medicine, arts, and the ordinary affairs of life. These substances have very peculiar properties, by which they differ from all other bodies.

The natural bodies from which metals differ the least are, earthy and pyritous matters, on account of their solidity and density. Metals and stones are, nevertheless, very different; the heaviest stones which are unmetallic being much lighter than the lightest metals. A cubic foot of marble weighs 252 pounds; and an equal bulk of tin, the lightest of metals, weighs 516 pounds. The difference is much greater when the weight of such a stone is compared with that of gold, a cubic foot of which is 1326 pounds.

Opacity is another quality which metals possess eminently, the opacity of metals being much greater than that of any unmetallic substance.

This great opacity of metals is a consequence of their density; and these two properties produce a third, peculiar also to metals, namely, a capacity of reflecting much more light than any other body: hence metals whose surfaces are polished, form mirrors representing the images of bodies more clearly than any other matter. Thus looking-glasses produce their reflexion merely by the silvring, which is a covering of metal upon their surfaces. To this reflective property metals owe their peculiar lustre, called the *metallic lustre*.

Although the several metallic substances differ considerably in hardness and fusibility, we may say in general, that they are less hard and less fusible than pure earths.

Metals cannot unite with any earthy substance, not even with their own earths, when these are deprived of their metallic state: hence, when they are melted, they naturally run into globes, as much as the absolute gravity of their mass, and their pressure upon the containing vessels, will allow. Accordingly, the surface of a metal in fusion is always convex. A metal in that state always endeavours to acquire a spherical form, which it does more perfectly as the mass is less. This effect is very sensible in quicksilver, which is nothing but a metal habitually fluid or fused. A mass of several pounds of mercury, contained in a shallow wide-mouthed vessel, is so spread out, that its upper surface is almost flat, and the convexity is not very sensible but at its circumference: on the contrary, if we put very small masses of mercury into the same vessel, as, for instance, masses weighing a grain each, they become so round as to seem perfect globes. This effect is partly occasioned by the inaptitude of metals to unite with the vessels containing them when in fusion, by

which quality the whole affinity which subsists betwixt the integrant parts of these metals is capable of acting; and partly also by this affinity, which disposes the integrant parts to come as near to each other as they can, and consequently to form a sphere.

This property is not peculiar to melted metals, but to all fluids, when contiguous to bodies solid or fluid, with which they have no tendency to unite. Thus, for instance, masses of water upon oily bodies, or oily masses upon bodies moistened with water, assume always a form so much nearer to the spherical as they are smaller. Even a large drop of oil poured upon a watery liquor, so that it shall be surrounded with this liquor, becomes a perfect sphere.

All metals are in general soluble by all acids; but often these solutions require particular treatment and circumstances, which are mentioned under CHEMISTRY, sect. iv. With acids, they form a kind of neutral salts, which have all more or less causticity. The affinity of metals is less than of absorbent earths and alkaline salts to acids; and therefore any metal may be separated from any acid by these earthy and saline alkalis.

Alkaline salts are capable of acting upon all metallic substances, and of keeping them dissolved by proper management.

Metals may in general be united with sulphur and liver of sulphur. With sulphur, they form compounds resembling the peculiar substance of ores, which are generally nothing else than natural combinations of sulphur and metal. Metals have less affinity with sulphur than with acids; hence sulphur may be separated from them by acids. Some exceptions from these general rules, concerning the affinity of metals to sulphur and liver of sulphur, and concerning their separation from sulphur by acids, may be seen under the articles of the several metals. But these exceptions do probably take place, only because we have not yet found the method of surmounting some obstacles which occur in the ordinary methods of treating certain metals.

All metals may in general be united with each other, with which they form different alloys which have peculiar properties; but this rule also is not without some exceptions.

Metals have strong affinity with the inflammable principle, and are capable of receiving it superabundantly.

Lastly, oily substances seem to be capable of acting upon all metals. Some metals are easily and copiously dissolved by oils; and perhaps they might all be found to be entirely soluble in oils, if the methods known in chemistry were tried for the accomplishment of these solutions.

The properties abovementioned agree in general to all metallic substances: but, besides the properties peculiar to each metal, some properties are common to a certain number of them; and hence they have been divided into several classes.

Those metallic matters which, when struck by a hammer, or strongly compressed, are extended, lengthened,

ened, and flattened, without being broken, (which property is called *ductility* or *malleability*), and which also remain fixed in the most violent and long continued fire, without diminution of weight, or other sensible alteration, are called *perfect metals*. These perfect metals are three; *gold, silver, platinum*.

The metallic matters which are ductile and fixed in the fire, to a certain degree, but which are destroyed by the continued action of fire, that is, changed into an earth deprived of all the characteristic properties of metals, are called *imperfect metals*. Of this kind are four; *copper, iron, tin, lead*.

The metallic substances which, as well as the imperfect metals, lose their metallic properties by exposure to fire, but which also have no ductility nor fixity, are distinguished from the others by the name of *semi-metals*. Of this class are five; *regulus of antimony, bismuth, zinc, regulus of cobalt, and regulus of arsenic*.

Lastly, *mercury*, which has all the general properties of metals, makes a class separate from the others; because in purity and gravity it is similar to the perfect metals, and in volatility to the semi-metals. Its fusibility also far surpasses that of any other metallic matter, that it is sufficient to distinguish it from all, and to give it a distinct class. We have enumerated, therefore, in all, 13 metallic substances; two of which only were unknown to the ancients, namely, *platinum* and *regulus of cobalt*. We have reason to wonder that these two metallic bodies, and particularly *platinum*, which is a perfect metal, should have remained unknown till lately.

This may give us cause to hope, that if natural history and chemistry be carefully cultivated, as they have been since the renovation of the sciences, we may still make essential discoveries in this way. Mr Cronstedt has given, in the Swedish Memoirs, a description of a metallic matter, which, as he says, appears to be a new semimetal distinct from the others. In that case, this would be the fourteenth metallic matter known, and the third lately discovered: but as, since the Memoir of Mr Cronstedt, this new semimetal has not been examined by chemists, it is yet but little known; and therefore further experiments seem requisite to decide whether it ought to be admitted as a new semimetal (A).

As chemists can only know compound bodies by being capable of separating the principles of such bodies, and even of re-uniting their principles so as to reproduce such compounds as they were originally; and as hitherto they have not been able to accomplish any such decomposition upon the perfect metals; hence, if all the other metallic substances were equally unalterable, we should be very far from having certain notions concerning metals in general: but if we except gold, silver, and platinum, all the other metallic matters are susceptible of decomposition and of recomposition, at least to a certain degree; and the experiments of this kind made by chemists, and chiefly by the modern chemists, have thrown much light on this important subject.

We may observe, that even if we had not been able

to decompose any metallic substance, we might still, by reflecting on the essential properties of metals, discover sufficiently well the nature of their principles.

The solidity, the consistence, and especially the gravity, which they possess in a degree so superior to all other bodies, would not have allowed us to doubt that the earthy element, of which these are the characteristic properties, enters largely into their composition, and makes their basis.

The facility with which they combine with almost all inflammable matters, and with all those which have great affinity with phlogiston, such as acids; joined to their incapacity of being alloyed with meagre matters that are purely earthy or purely watery, which have no disposition to unite with phlogiston; would also have furnished very strong motives to believe, that the inflammable principle enters largely into the composition of metals.

We must acknowledge, however, that these considerations would only have furnished concerning the existence of the inflammable principle in metals, but a simple probability, very far from the complete proof we now have: but the combustibility of all metals capable of decomposition by this method, and of the subsequent reduction, with all their properties, by the rejunction of the inflammable principle, furnishes the clearest and the most satisfactory demonstration that we have in chemistry. We shall now mention what is known upon this subject, and the consequences necessarily resulting.

The destructible metals present exactly the same phenomena as all other bodies containing the inflammable principle do, in the state of combustion. When exposed to fire, without access of air, that is, in close vessels, they become red-hot, melt, or sublime, according to their nature: but they receive no alteration in their composition from fire applied in this manner, and they are afterwards found to be exactly in the same state as before. In this respect, they resemble perfectly all bodies which contain no other inflammable matter than pure phlogiston.

But when imperfect metals are exposed to fire, with access of air, as, for instance, under a muffle in a furnace which is made very hot, then they burn more or less sensibly, as their inflammable principle is more or less abundant, or more or less combined. Some of them, as iron and zinc, burn with a very lively and brilliant flame; but this flame is of the same nature as that of charcoal, of sulphur, of all bodies, the combustible principle of which is pure phlogiston, and is not in an oily state, that is, furnishes no foot capable of blackening.

Also the imperfect metals detonate with nitre, when all the circumstances which that detonation requires are united\*. Their phlogiston is consumed by this method much more quickly and completely than by ordinary calcination or combustion. Their flame is also much more lively and brilliant; and some of them, as iron and zinc, are used in compositions for fireworks, from their very vivid and beautiful flame.

Nitre is alkaliified by these metallic detonations exactly in the same manner as in its detonation by coals.

Lastly,

(A) See NICKEL. Mr Justi pretends that he has discovered a new metallic substance contained in yellow mica. This, he says, was of a blackish grey colour; but when mixed with gold heightened the lustre, without destroying the malleability of that metal, though it itself is brittle.

\* See Detonation.

Lastly, imperfect metals being treated with acids which have an affinity with phlogiston, that is, with the vitriolic and nitrous acids, are deprived also by these acids of a more or less considerable part of their inflammable principle; they give a sulphureous quality to vitriolic acid, and are even capable of furnishing sulphur with that acid.

Although the experiments now mentioned were the only proofs of the existence of an inflammable principle in metallic substances, these would be sufficient to establish it incontestably. But we shall see, when we continue to examine the phenomena attending the decomposition of metals, that those are not the only proofs.

If the inflammable matter which flows itself so evidently in the burning of metals, is really one of their constituent parts, their essential properties must be altered in proportion to the quantity of it taken from them: and this evidently happens upon trial; for the residuum of metallic matters, after calcination, departs from the metallic character, and approaches to the nature of mere earth. The opacity, brilliancy, ductility, gravity, fusibility, volatility, in a word, all the properties by which metallic substances differ from simple earths, diminish or entirely disappear, by taking from them their inflammable principle; so that when their calcination has been carried as far as is possible, they resemble mere earths, and have no longer any thing in common with metals. These earths can no longer be combined with acids or with metals, but are capable of uniting with pure earths. They are then called *calxes* or *metallic earths*. See CHEMISTRY, n° 44, 45.

We must observe concerning the decomposition of metals, 1. That when only a small quantity of inflammable principle is taken from metals, a small quantity only of calx is formed, and the remaining part continues in the metallic state: hence, as the portion of calcined metal can no longer remain united with the undestroyed metal, it separates in form of scales from the surface of the metal when the calcination has been performed without fusion, as generally happens to iron and to copper; or these scales float upon the surface of the melted matter when the calcination is performed during fusion, because the calx is specifically lighter than the metal; as happens to the very fusible metals, as tin, lead, and most of the femimetals.

2. The imperfect metals are not all equally easily and completely calcinable. In general, as much of their phlogiston may be easily taken from them, as is sufficient to deprive them of their metallic properties; but the remaining portion of their phlogiston cannot be so easily driven from them. Some of them, as copper, resist the first calcination more than the rest; and others, as lead and bismuth, may be very easily calcined, but only to a certain degree, and retain always obstinately the last portions of their inflammable principle; lastly, others, as tin and regulus of antimony, may not only be easily and quickly calcined, but also much more completely. All the other metals partake more or less of these properties relating to their calcination. In general, if we except the labours of alchemists, which are not much to be depended upon, we have not yet made all the proper efforts to arrive at a perfect calcination of the several metallic substances; which, however, is absolutely necessary, before we can arrive at a complete knowledge of the nature of their earths, as we shall afterwards see.

When metallic earths have lost but little of their phlogiston, and are exposed to strong fire, they melt, and are reduced to compact masses, still heavy and opaque, although much less so than the metals, and always brittle and absolutely unmalleanable. If the calcination has been more perfect, the metallic earths are still fusible by fire, but less easily, and convertible into brittle and transparent masses possessed of all the properties of glass, and are accordingly called *metallic glasses*. These glasses do not possess any of the properties of their metals, excepting that they are specifically heavier than other glasses, that they are capable of being attacked by acids, and that the glasses of the femimetals are somewhat less fixed than unmetallic glasses. Lastly, when the calcination of metals has been carried to its greatest height, their earths are absolutely fixed, and unfusible in the fire of our furnaces, and possess no longer the solubility in acids by which metals are characterized.

These are the principal changes which metals suffer by losing their phlogiston. They are thus changed into substances which have no properties but those of earth. This is a certain proof that the inflammable principle is one of their constituent parts. But we have also other proofs of this important truth. The reduction of metallic calxes into metal, by the addition of phlogiston alone, completes the proof; and the whole forms one of the clearest and most satisfactory demonstrations in all the sciences. This reduction is effected in the following manner.

If the earth of a metal be mixed with any inflammable matter, which either is or can be changed into the state of coal, together with some salt capable of facilitating fusion, but which, from its quantity or quality, is incapable of receiving the inflammable principle; and if the whole be put into a crucible, and the fusion promoted by a fire gradually raised; then an effervescence will happen, accompanied with a hissing noise, which continues a certain time, during which the fire is not to be increased; afterwards, when the whole has been well fused, and the crucible taken from the fire and cooled, we shall find at the bottom, upon breaking it, the metal, the earth of which was employed for the operation, possessed of all the properties which it had before calcination and reduction. See REDUCTION.

We cannot doubt that this wonderful transformation of an earthy substance into a metal, is solely caused by the phlogiston passing from the inflammable matter to the metallic earth: for, first, in whatever manner and with whatever substance metallic earths be treated, they cannot be ever reduced into metals without a concurrence of some substance containing phlogiston. 2dly, The nature of the substance which is to furnish phlogiston is quite indifferent, because this principle is the same in all bodies containing it. 3dly, If, after the operation, the substance furnishing the phlogiston be examined, we shall find that it has lost as much of that principle as the metallic earth has received.

The facts related concerning the decomposition and the recomposition of metals prove incontestably, that they are all composed of earth and phlogiston. But we do not yet certainly know whether these two be the only principles of metals. We might affirm this, if we could produce metals by combining phlogiston with some matter which is certainly known to be simple earth.

earth. But this hitherto has not been accomplished; for if we try to treat any earth, which has never been metallic, with inflammable matters, we shall perceive that the simple earths are not combinable with phlogiston so as to form metals. We shall even perceive that the metallic earths resist this combination, and are incapable of reduction into metal, when they have been so much calcined as very nearly to approximate the nature of simple earths.

These considerations, added to this, that we cannot easily conceive how, from only two certain principles, so many very different compounds as the several metallic substances are, should result, are capable of inducing a belief that some other principle is added to these two already mentioned in the composition of metals.

Many great chemists, and particularly Becher and Stahl, seem to be convinced of this opinion; and chiefly from the experiments concerning the mercuration of metals, they believe that this third principle exists copiously in mercury; that it is of a mercurial nature; that it also exists in marine acid, to which it gives its specific character; that by extracting this mercurial principle from marine acid, or any other body containing it copiously, and by combining it with simple earths, these may acquire a metallic character, and be rendered capable of receiving phlogiston, and of being completely metallized.

These chemists admit also, and with probability, a different proportion of metallic principles in the several metals; and believe, that particularly the principle which they call *mercurial earth*, exists more copiously and sensibly in certain metals than in others. The most mercurial metals, according to them, are mercury, silver, lead, and arsenic. Most chemists distinguish from the other metals, silver, mercury, and lead; which they call *white metals*, *lunar metals*, or *mercurial metals*.

All these considerations being united, and others too many to be mentioned, give some probability to the existence of the mercurial principle in metals. We must however acknowledge, that the existence of this principle is only merely probable; and, as Stahl observes, is not nearly so well demonstrated as that of the inflammable principle: we may even add, that we have strong motives to doubt of its existence.

To produce metals artificially has justly been reckoned one of the most difficult problems in chemistry. The reflections we shall add upon this subject will be sufficient demonstration to every sensible person, that great knowledge is requisite in that science, to attempt with any hopes of success the production even of the most imperfect femetal. Even if we were certain that it depends only on the intimate combination of the inflammable principle with a matter simply earthy, we should labour by chance, and without any reasonable expectation of success, if we were to attempt that combination without having more knowledge than we now possess, concerning the true nature of the earthy principle which enters into the composition of metals; for we must acknowledge that chemistry has made but little progress in this matter.

Metallic substances, although they resemble each other by the general properties mentioned in the beginning of this article, differ nevertheless from each other very evidently by the properties peculiar to each. Do these differences proceed from the different propor-

tion, and from the more or less intimate connection of the inflammable principle with the earthy principle; supposing that this latter should be essentially the same in all metals? or ought they to be attributed to the difference of earths, which in that case would be distinct and peculiar to each metal? or, lastly, do metals differ from each other, both by the nature of their earths, and by the proportion and intimacy of connection of their principles? All these things are entirely unknown; and we may easily perceive, that till they are known, we cannot discover what method to pursue in our attempts to accomplish the combinations we are now treating of.

The most essential point then is, to arrive at a knowledge of the true nature of the earths which are in metals; and the only method of arriving at this knowledge is, to reduce them to their greatest simplicity by a perfect calcination. But this cannot be accomplished but by long and difficult operations. We have seen above, that all metals are not calcinable with equal ease; that the perfect metals have not been hitherto calcined truly by any process; and that in general, the last portions of phlogiston adhere very strongly to calcinable metals.

Some metals, however, as tin and regulus of antimony, may be easily calcined so as to be rendered irreducible. By carrying the calcination still further by the methods known in chemistry, we might obtain their earths so pure, that all their essential properties may be discovered, by which they might be easily compared together. This comparison would decide whether their nature be essentially different or not.

If they were found to be composed of earths essentially the same, we might next proceed to compare metallic with unmetallic earths. If the former were found similar to some of the latter kind, we should be then assured that the earth of metals is not peculiar to them, and that ordinary unmetallic earths are susceptible of metallification.

The greater the number of metals operated upon, the more general and certain the consequences resulting from these would be: so that, for instance, if the operation were extended to all calcinable metals; and if the result of each of these operations were, that the calxes, when perfectly dephlogisticated, do not differ from each other, and are similar to earths already known; we might conclude from analogy, and we should be almost certain, that the earths of the perfect metals are also of the same nature.

They who know the extent and difficulties of chemical operations, will easily perceive that this would be one of the most considerable. Nevertheless, after having determined this essential point, we should only have done half our work. For a knowledge of the nature of the earth of metals, and where it is to be found, would not be sufficient; we must further endeavour to find a method of combining with this earth a sufficient quantity of phlogiston, and in a manner sufficiently intimate, that a metal might be formed by such a combination. But this second difficulty is perhaps greater than the former.

We must observe here, that some famous chemical processes have been considered by many as metallifications, but which are really not so. Such is Becher's famous experiment of the *minera arenaria perpetua*,  
by



by which chemist proposed to the States General to extract gold from any kind of sand. Such also is the process of Becher and of Geoffroy, to obtain iron from all clays by treating them with linseed oil in close vessels. In these, and many other such processes, we do only obtain metal that was already formed. Every earth and sand, as the intelligent and judicious Cramer observes, contain some particles of gold. Clays do not commonly contain iron ready formed; but all of them contain a ferruginous earth, naturally disposed to metallification. See CLAY. Accordingly we must conclude, that, by Mr Geoffroy's experiment, iron is only reduced or revived, but is not produced.

The great difficulties which occur in attempting to give a metallic quality to simple earths have induced a belief, that the nature of metals ready formed might be more easily changed, and the less perfect brought to a more perfect state. To effect this, which is one of the principal objects of alchemy, and is called *transmutation*, numberless trials have been made. As we have not any certain knowledge of what occasions the specific differences of metallic substances, we cannot decide whether transmutation be possible or not. In fact, if each metallic substance have its peculiar earth, essentially different from the earths of the others, and consequently if the differences of metals proceed from the differences of their earths; then, as we cannot change the essential properties of any simple substance, transmutation of metals must be impossible. But if the earths and other principles of metals be essentially the same, if they be combined in different proportions only, and more or less strictly united, and if this be the only cause of the specific difference of metals, we then see no impossibility in their transmutation.

Whatever be the cause of the differences of metals, their transmutation seems to be no less difficult than the production of a new metallic substance; and perhaps it is even more difficult. Alchemists believe that transmutation is possible, and they even affirm that they have effected it. They begin by supposing that all metals are composed of the same principles; and that the imperfect metals do not differ from gold and silver, but because their principles are not so well combined, or because they contain heterogeneous matters. We have then only these two faults to remedy, which, as they say, may be done by a proper coction, and by separating the pure from the impure. As we have but very vague and superficial notions concerning the causes of the differences of metals, we confess that we cannot make any reasonable conjecture upon this matter; and we shall only advise those who would proceed upon good principles, to determine previously, if metals have each a peculiar earth, or only one common to them all. In the second place, if it should be demonstrated that the earthy principle is the same in all metals, and if that be demonstrated as clearly as the identity of the inflammable principle in metals is proved; they must then determine whether these two be the only principles in metals, whether the mercurial principle exists, and whether it be essential to all metals or to some only, and what is the proportion of these two or three principles in the several metallic substances. When we shall clearly understand these principal objects, we may then be able to determine

concerning the possibility of transmutation; and if the possibility should be affirmed, we shall then begin to discover the road which we ought to pursue.

We have no reason to believe that any other principle enters into the composition of metals than those above-mentioned: no vestige is perceptible of either air or water. Some chemists have nevertheless advanced that they contain a saline principle. If that were true, they would also contain a watery principle. But all the experiments adduced to prove this opinion are either false, or only show the presence of some saline particles extraneous to the metals, or contained unknown to the chemists in the substances employed in the experiments. For metals perfectly pure, subjected to all trials with substances which do not contain and which cannot produce any thing saline, do not discover any saline property. We must however except arsenic, and even its regulus, these being singular substances, in which the saline are as sensible as the metallic properties.

Arsenic seems to be one of those intermediate substances which nature has placed in almost all its productions betwixt two different kinds, and which partake of the properties of each kind. Arsenic thus placed betwixt metallic and saline substances has properties common to both these kinds of substances, without being either entirely a metal or salt. See ARSENIC.

As water seems to act to a certain degree upon iron, even without the concurrence of air, as the operation of *martial ethiops* shews, we might thence suspect something saline in that metal. Nevertheless, what happens in that operation has not been so well explained, that any certain consequences can be deduced. 1. The water employed ought to be perfectly pure; that is, distilled rain-water. 2. The iron employed ought also to be perfectly pure, and such is very difficultly to be procured. 3. The operation ought to be performed in a bottle accurately closed, that we may be assured that the air contributes nothing to the action upon the iron. 4. After the water has remained a long time, suppose a year, upon the iron, the water ought to be carefully filtrated and examined, to ascertain whether it really has dissolved any part of the metal.

In the mean time, we may conclude that metals do not seem to contain any saline principle. And when we consider well their general properties, they seem to be nothing else than earths combined more or less intimately with a large quantity of phlogiston. Although we can demonstrate that their inflammable principle is not in an oily state, and that it is pure phlogiston, they have nevertheless an oily appearance, in this circumstance, that they adhere no more than oils to earthy and aqueous substances, and that they always assume a globular figure when supported by these substances entirely free from phlogiston.

This resemblance is so sensible, that chemists, before they knew the nature of phlogiston, believed that metals contained an oily and fat matter; and even now many persons, who talk of chemistry without understanding it, speak of the *oil* or *fat* of metals; expressions, which do not found well to genuine chemists. The cause of this quality of metals is the quantity of phlogiston which they contain. Sulphur, phosphorus, oils, and even fats, have this appearance

merely from the inflammable principle which enters into their composition : for this property is communicated by that principle to every compound which contains a certain quantity of it. See PHLOGISTON.

When the phlogiston combines copiously and intimately with earthy matters so as to form metals, it probably so disposes them, that the primitive integral parts of the new compound, that is, of the metal, approximate and touch each other much more than the integral parts of simple earths can. This is proved by the great density or specific gravity, and other general properties, of metals.

In fact, as we cannot conceive that a body should be transparent, unless it have pores and interstices through which rays of light can pass; therefore the more dense a body is, that is, the fewer such interstices it has, the less transparent it will be; so that the densest bodies ought to be the most opaque, as in metals. The disposition of the pores of bodies contributes also much to their greater or less transparency; and bodies, the pores of which are continued and straight, are more transparent than those whose pores are interrupted, transverse, or oblique; so that a body may be much more transparent than another which is less dense, as we see that glass is more transparent than charcoal. But when other circumstances are equal, the densest bodies are the most opaque. Therefore the opacity of bodies is proportionable to their density, and to the deviation of their pores from right and parallel lines.

From the great opacity of metals, they probably possess both these qualities in an eminent degree. We have seen, at the beginning of this article, that the lustre of metals, and their property of reflecting light much better than any other substance, are necessary consequences of their opacity. This is also self-evident, because the fewer rays any body can transmit, the more it must reflect.

Lastly, the ductility of metals proceeds also from their density, and from the disposition of their pores. Phlogiston also appears to communicate ductility to most of the bodies containing it; as we see in sulphur, and in unctuous bodies, as resins, wax, &c. all which are more or less ductile, at least when heated to a certain degree. Lastly, the softness, fusibility, and volatility, of which all metals partake more or less, and which many of them possess in a superior degree, being properties entirely contrary to those of the earthy principle, probably proceed from the inflammable principle. In general, if we reflect on the essential properties of the earthy and inflammable principles, we shall easily perceive that these properties, being combined and modified by each other, ought to produce the properties of metals.

The order in which metals compared with each other possess most eminently their principal properties, is the same as that in which they are here enumerated, according to Mr Macquer, beginning always with that metal in which the property is most considerable.

1. *Specific gravity or density.* Gold, platina, mercury, lead, silver, copper, iron, and tin.

2. *Opacity.* We cannot well compare metals with each other in this respect, because it is so considerable in all, that it seems complete. If, however, they

differ in this respect, the same order will serve for opacity as for density.

3. *Metallic lustre or brilliancy.* The same observation which was made concerning the last-mentioned property is applicable to this also. We must however observe, that as by polish bodies are rendered brighter, and that as whiteness contributes much to the reflexion of light, the whitest and hardest metals therefore reflect best. Hence, according to Mr Macquer, platina ought to be placed first; and then iron, or rather steel, silver, gold, copper, tin, lead.

Hardness of metals may contribute much to the duration of their polish; but certainly soft metals, if their texture be equally compact, are no less capable of receiving a polish than hard metals. Some hard metallic alloys have been found to be less liable to tarnish than softer compounds, and have for this reason also been chiefly used for speculums. The property of reflecting light seems chiefly to depend on the closeness of the particles, or on the density, on the smoothness of the surface, and on the colour being most similar to the colour of the light to be reflected. The white metals, silver, mercury, tin, reflect light more abundantly than others. Gold, being the densest metal, and perhaps because the colour of solar light has a slightly-yellowish tinge, does also reflect light very copiously. Hence speculums made of leaf-gold have been found to be very effectual. Iron or steel reflects much less light than any of the above-mentioned metals, altho' Mr Macquer has considered it as capable of a greater reflective power. Platina is generally in so small grains, that its reflective power cannot easily be determined. The precise degrees of that power which ought to be assigned to each of the above-mentioned metals, cannot without accurate experiments be ascertained. Perhaps, however, their reflective powers will be found to be more nearly in the following order, than in that above-mentioned from Mr Macquer. Silver, quicksilver, tin, gold, copper, iron, lead.

4. *Ductility.* Gold, silver, copper, iron, tin, lead. The ductility of mercury and that of platina are not yet determined.

5. *Hardness.* Iron, platina, copper, silver, gold, tin, and lead.

6. *Tenacity.* By tenacity we understand the force with which the integral parts of metals resist their separation. This force appears to be in a compound ratio of their ductility and hardness. The comparative tenacity of metals is measured by the weight which wires of the same diameter, made of the several metals, can sustain without breaking. Gold is the most tenacious, then iron, copper, silver, tin, lead. The tenacity of mercury is unknown: that of platina is not yet determined, but is probably considerable.

7. *Fusibility.* Mercury, tin, lead, silver, gold, copper, iron, and lastly platina, which cannot be fused by the greatest fire of our furnaces, but only by the solar focus, as Messrs Macquer and Beaumé have determined.

## SECT. II. Of Mines and Ores in general.

THE substances found naturally combined with metals, in the earth, are, particularly, sulphur and arsenic, sometimes separately, but generally conjointly.

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Metals combined with these substances are called *metals mineralized by sulphur*, or *by arsenic*, or *by sulphur and arsenic*; and these matters are called *mineralizing substances*.

Besides the sulphur and arsenic with which metals are strictly combined in the mineral state, they are also pretty intimately combined with earthy substances, of different natures, and more or less divided.

These different matters united together form masses which are compact, heavy, brittle, and frequently possessed of much metallic lustre. These substances are properly called *ores*, or the matter of mines.

These ores are found in earths and stones of different kinds, as sands, flints, crystals, slates, indurated clays, according to the ground in which they are contained. But two kinds of stones in particular seem to accompany ores; and have therefore been considered by several mineralogists as matrixes, in which metals are formed. One of these stones is a kind of crystal, generally white, milky, and semi-opaque, striking fire with steel, and of the class of vitrifiable earths. It is called *QUARTZ*.

The other stone is less hard, which does not strike fire with steel, and is sometimes milky like quartz; sometimes transparent and diversely coloured, consisting of rhomboidal crystals, which are composed of plates and faces. This stone becomes more soft and friable by being exposed to fire. It is called *SPAR*. Spar is more like to gypseous stones than to any other, but it differs from gypseous stones in possessing a much greater density. Some spars are so heavy, that they exceed in this respect all other stones. See *SPAR*.

These earthy and stony substances form the *matrix of the ore*.

Ores are natural compounds, containing metals alloyed with different substances.

Excepting gold, and a very small quantity of each of the other metals found in some places so pure as to possess all their characteristic properties, nature exhibits to us metals and semimetals differently alloyed not only with each other, but also with several heterogeneous substances, which so alter and disguise their qualities, that in this state they cannot serve for any of the purposes for which they are proper when they are sufficiently pure.

Ores consist, 1. Of metallic substances *calcined*; or, 2. Of these substances combined with other matters, with which they are said to be *mineralized*.

Calcined metallic substances, or *calciniform ores*, are metallic substances deprived of phlogiston, and in the state of a calx or metallic earth. Such are all *ferruginous ochres*, which are calxes of iron.

*Mineralized ores*, are, 1. *Simple*, containing only one metallic substance: or, 2. *Compound*, containing two or more metallic substances.

Of the simple, and also of the compound ores, four kinds may be distinguished.

1. Ores consisting of metallic substances mineralized by *sulphur*. Such is the lead-ore called *galena*, composed of lead and sulphur.

2. Ores consisting of metallic substances mineralized by *arsenic*. Such is the *white pyrites*, containing iron and arsenic.

3. Ores consisting of metallic substances mineralized by *sulphur and by arsenic*. Such is the *red silver-ore*, containing silver, arsenic, and sulphur.

4. Ores consisting of metallic substances mineralized by *saline matters*. Such are the *native vitriols*. Such also is probably the *corneous silver-ore*, which, according to Mr Cronstedt's opinion, is a luna cornea, or silver combined with marine acid. Of this kind of ores, or native metallic salts, is perhaps the *sedative salt of borax*, which from Mr Cadet's experiments, published in the Memoirs of the Royal Academy for the year 1766, is conjectured to be copper combined with marine acid, and which has been said to be found native. To this class also may be referred the *silver mineralized by an alkaline substance*, which Mr Von Justi pretends to have discovered.

Henckel, and after him Cramer, and the author of the Dictionary of Chemistry, pretend, that in mineralized ores, besides the above-mentioned metallic and mineralizing substances, are also contained a metallic and an unmetallic earth. But Wallerius affirms, that the existence of such earths cannot be shewn, and that sulphur is incapable of dissolving unmetallic earths, and even the calxes of all metallic substances, excepting those of lead, bismuth, and nickel.

Having thus defined and distinguished the several general classes of ores, we proceed to shew how they are lodged, and where they are found.

*Metals and metalliferous ores are found in various places.*

I. They are found *under water*; in beds of rivers, lakes, and seas, and chiefly at the flexures of these: such are the auriferous and ferruginous sands, grains of native gold, ochres, and fragments of ores washed from mines.

II. They are found *dissolved in water*: such are the vitriolic waters containing iron, copper, or zinc.

III. They are found *upon the surface of the earth*. Such are many ochres; metalliferous stones, sands, and clays; and lumps of ores. Mr Gmelin says, that in the northern parts of Asia ores are almost always found upon or near the surface of the ground.

IV. They are found *under the surface of the earth*. When the quantity of these collected in one place is considerable, it is called a *mine*.

Subterranean metals and ores are differently disposed in different places.

1. Some are *influxed in stones and earths*, formed nodules or spots diversely coloured.

2. Some are equally and uniformly diffused through the substance of earths and stones, to which they give colour, density, and other properties. Such are the greatest part of those earths, stones, sands, clays, crystals, flints, gems, and slonors, which are coloured.

3. Some form *strata* in mountains. Such are the slates containing pyrites, copper-ore, lead-ore, silver-ore, or blend. These lie in the same direction as the strata of stones betwixt which they are placed; but they differ from the ordinary strata in this circumstance, that the thickness of different parts of the same metalliferous stratum is often very various; whereas the thickness of the stony strata is known to be generally very uniform.

4. *Fragments of ores* are frequently found accumulated in certain subterranean cavities, in fissures of mountains, or interposed betwixt the strata of the earth.

earth. These are loose, unconnected, frequently involved in clay, and not accreted to the contiguous rocks or strata immediately, nor by intervention of spar or of quartz, as the ores found in veins are. Tin and iron mines are frequently of the kind here described.

5. Large entire masses of ores are sometimes found in the stony strata of mountains. These are improperly called *accumulated veins*, because their length, relatively to their breadth and depth, is not considerable.

6. Some instances are mentioned of *entire mountains* consisting of ore. Such is the mountain Taberg in Smoland; and such are the mountains of Keruavara and Luofavara in Lapland, the former of which is 1400 perches long and 100 perches broad. These mountains consist of iron-ore.

9. Lastly, and chiefly, metals and ores are found in oblong tracts, forming masses called *veins*, which lie in the stony strata composing mountains.

The direction of veins greatly varies; some being straight, and others curved. Their position also respecting the horizon is very various; some being perpendicular, some horizontal, and the rest being of the intermediate degrees of declivity.

The dimensions, the quality, and the quantity of contents, and many other circumstances of veins, are also very various. Miners distinguish the several kinds of veins by names expressive of their differences. Thus veins are said to be *deep*; *perpendicular*; *horizontal*, or *hanging*, or *dilated*; *rich*; *poor*; *morning*, *noon*, *evening*, and *night* veins, by which their direction towards that point of the compass where the sun is at any of these divisions of the natural day, is signified.

The stratum of earth or stone lying above a vein is called its *roof*; and the stratum under the vein is called its *floor*.

Some parts of veins are considerably thicker than others. Small veins frequently branch out from large veins, and sometimes these branches return into the trunk from which they issued. These veins from which many smaller veins depart, have been observed to be generally rich.

*Veins are terminated* variously: 1. By a gradual diminution, as if they had been compressed, while yet soft, by superincumbent weight; or by splitting and dividing into several smaller veins. Or, 2. They are terminated abruptly, together with their proper strata in which they lie. This abrupt termination of veins and strata is occasioned by their being crossed by new strata running transversely to the direction of the former; or by perpendicular fissures through the strata; which fissures are frequently filled with alluvial matters, or with water, or are empty. These perpendicular fissures seem to have been occasioned by some rupture or derangement of the stratum through which the vein passes, by which one part of it has been raised or depressed, or removed aside from the other, probably by earthquakes. Where the veins are terminated abruptly, it does not cease, but is only broken and disjointed; and is often recovered by searching in the analogous parts of the opposite side of the deranged stratum. A principal part of the art of miners consists in discovering the modes of these derangements from external marks, that they may know where to search

for the disjointed vein.

The contents of veins are metals and metalliferous minerals; as, the several kinds of ores, pyrites, blends, gubrs, vitriols; the several kinds of fluors, spars, quartz, horn-blend, in which the ores are generally embedded, or enveloped, and to which therefore the name *matrix of the ore* is applied; stalaçites; crystallizations of these metalliferous and stony substances encrusting the small cavities of the circumjacent rock; and lastly, water, which flows or drops through crevices in that rock.

In a vein, ores are found sometimes attached to the rock or stratum through which the vein runs, but more frequently to a matrix which adheres to the rock; and sometimes both these kinds of adhesion occur in the same vein at different places. Frequently betwixt the matrix and the rock is interposed a thin crust of iron ore or of earth, called by authors the *finbria of the ore*.

The matrix or the stone in which the ore lies enveloped is of various kinds in different veins. And some kinds of stone seem better adapted than others to give reception to any ore, or to the ores of particular metals. Thus quartz, spar, fluors, and hornblend, give reception to all ores and metals; but slates, chiefly to copper and silver, and never to tin; calcareous and sparry matrices, to lead, silver, and tin; and mica to iron.

*Veins* lie in strata of different kinds of stone; but more frequently in some kinds of stone than in others. Thus of the simple or uncompounded stones which compose strata, the following are metalliferous: *Calcareous stones*; *slaty sand-stone* (cos fillis arenosis Wallerii); *feldspar* (spatum pyramachum sive scintillans); *quartz*; sometimes *jasper*; frequently *slates*; and chiefly *micaceous* or *talky* stones; and *hornblend*, (lapis corneus Wallerii; bolus indurata particulis squamosis Cronstedt). No veins have been found in gypsiferous or in siliceous strata, although *chert* and *flints* frequently contain metallic particles, and some instances have been observed of ores of silver and of tin in *alabaster*. Of compound stones, those are said to be chiefly metalliferous which consist of particles of hornblend. Veins have also been found in the *red granite*; but seldom, if ever, in any other *granite*, or in *porphyry*. In general, veins are more frequently found in soft, fissile, and friable strata, than in those which are compact and hard.

A vein sometimes passes from one stratum into the inferior contiguous stratum. Sometimes even the veins of one stratum do so correspond with those of an inferior stratum, the contiguity of which with the former is interrupted by a mass of different matter thro' which the veins do not pass, that they seem originally to have been continued from one stratum to the other. Thus in the mines of Derbyshire, where the veins lie in strata of limestone, the contiguity of which strata with each other is interrupted in some places by a blue marle or clay, and in other places by a compound stone called *toadstone*; the veins of one stratum frequently correspond with the veins of the inferior stratum of limestone, but are never continued through the interposed clay or toadstone. But we must observe, that these interposed masses, the blue marle, clay, and toadstone, have not the uniform thickness

observable in regular strata, but are (especially the toadstone) in some places a few feet in depth, and in others some hundreds of yards. The above disposition seems to indicate, that these several strata of limestone have been originally contiguous; that the veins now disjointed have been once continued; that these strata of limestone have been afterwards separated by some violent cause, probably by the same earthquakes which have in a singular manner shattered the strata of this mountainous country; that the interstices thus formed between the separated strata have been filled with such matters as the waters could infiltrate, probably with the mixed comminuted ruins of shattered strata; or with the lava of neighbouring volcanoes, of which many vestiges remain.

To the above historical sketch of mines, we shall add some conjectural remarks concerning their *formation*.

Those ores which are found under water (I.); upon the surface of the earth (II.); in fissures of mountains and subterraneous cavities, accumulated, but not accreted to the contiguous rocks, (IV. 4.); seem from their loose, unconnected, broken appearances, to have been conveyed by alluvion.

All martial ochres have probably been separated from vitriolic ferruginous waters (II.) either spontaneously or by calcareous earth; and these waters seem to have acquired their metallic contents by dissolving the vitriol which is produced by the spontaneous decomposition of martial pyrites. The ochres of copper, zinc, and perhaps of several other metals, have probably been precipitated from vitriolic waters by some substance, as calcareous earth, more disposed to combine with acids; and these vitriolic waters have probably been rendered metalliferous, by dissolving the vitriols produced by a combustion of cupreous pyrites and of the ore of zinc called *blend*; for these minerals are not, as martial pyrites is, susceptible of decomposition spontaneously, that is, by air and moisture.

The metalliferous nodules and spots (IV. 1.) seem to have been infixed in stones while these were yet soft. Perhaps the metalliferous and lapideous particles were at once dissolved and suspended in the same aqueous menstruum, and during their concretion crystallized distinctly, as different salts do when dissolved in the same fluid.

The earths and stones uniformly coloured by metals (IV. 2.) were also probably in a soft state while they received these tinges. The opaque-coloured stones seem to have received their colour from metallic calxes mixed and diffused through the soft lapideous substance; and the transparent-coloured stones have probably received their colours from vitriolic salts, or from metallic particles dissolved in the same water which softened or liquefied the stony substance; which metallic salts and particles were so much diffused, that they could not be distinctly crystallized. That all stones have been once liquid and dissolved in water, appears probable not only from their regular crystallized forms, but also the solubility of some stones, as of gypsiferous and calcareous earths, in water; and from the water which we know is contained in the hardest marbles, as well as in alabasters; to which water these stones owe the crystallization of their particles.

The veins called *cumulated* (IV. 5.); and the en-

tire metalliferous mountains (IV. 6.), are believed by Wallerius to be analogous to the nodules (IV. 1.) These metalliferous substances seem to have been originally formed or concreted in the places where they are found.

The metalliferous strata (IV. 3.) have probably been insinuated between the lapideous strata, after the separation of these from each other by some violent cause; in the same manner in which we supposed that the clay and toadstone have been insinuated betwixt the several strata of lime-stone in Derbyshire. The matters thus insinuated may have been either fluid, which would afterwards crystallize and form entire regular masses; or they may have been the ruins of shattered strata and veins brought by waters, and there deposited; in which case they will appear broken and irregular. The metalliferous strata, although frequently confounded with the horizontal or dilated veins, may be distinguished, according to Wallerius, from these by the following properties: 1. They are generally thinner and much broader than the veins called *dilated*. 2. They are seldom found at a greater depth than 100 perches, and generally in the neighbourhood of veins from which they probably have received their contents. 3. From their want of the thin encrustations called *subria*; which, we observed, are frequently interposed betwixt the rock and the ore or its matrix; and from their want of the other properties of veins.

But in *veins* properly so called, the strongest marks exist of ores having been there concreted, and not carried thither and deposited in their present state. Their regular, unbroken appearance; their accretion to the contiguous rock, either immediately, or by intervention of a matrix; the regular appearance of this matrix enveloping the ore; the frequent crystallization of the ore, and of the other contents of the vein, indicate that ores, as well as the other solid contents, have been there concreted from a fluid to a solid state.

Most authors believe that veins, and the perpendicular clefts in the stony strata of mountains, called *fissures*, have been produced by the same cause; or rather, they consider veins only as fissures filled with metalliferous matters. They further believe, that fissures have been occasioned by the exsiccation of strata, while these were passing from a fluid to a solid state. Wallerius thinks, that fissures have been formed from exsiccation; but that veins were channels made through the strata, while yet soft and fluid, by water, or by the more fluid parts of the strata penetrating and forcing a passage through the more solid parts. He thinks, that these fluid parts conveyed thither their metalliferous and stony contents, which were there coagulated or concreted. He supports his opinion by observing, that all the veins of the same stratum generally run parallel to each other; that they frequently bend in their course; that the same vein is sometimes contracted, and sometimes dilated; that veins are frequently terminated by being split, or divided into inferior veins; that veins are frequently wider at bottom than at top, whereas fissures are always widest at top, and are very narrow below; all which appearances, he thinks, could not have been produced by exsiccation. From these reasons,

sons, fissures appear to have had a different, and, from the disjunction and rupture of veins crossed by fissures, they seem to have had a later origin than veins. Whether fissures could have been produced by the very gradual exsiccation of these large masses of strongly coherent matter; or whether they have been produced by the same violent causes, namely, *earthquakes*, by which the strata in which fissures are generally found have been broken and deranged, and by which metalliferous mountains themselves have been formed, or their strata raised above their original level, as some authors have with great probability conjectured, we do not pretend to determine.

Veins are seldom, if ever, found but in mountains. The reason of which may not improbably be, that in metalliferous mountains we have access to the more ancient strata of the earth, which in plains are covered with so many deposited, alluvial, and other later strata, that we can seldom, if ever, reach the former. That these mountains consist of strata which have been originally lower than the upper strata of adjacent plains, appears from an observation which has been made, that the strata of mountainous countries dip with more or less declivity as they approach the plains, till they gradually sink under the several strata of those plains, and are at last immersed beyond the reach of miners. This leading fact in the natural history of the earth has been observed by a sagacious philosopher, Mr Mitchell, in his *Conjectures concerning Earthquakes*, Phil. Trans. 1760.

That the inferior strata of the earth contain large quantities of pyritous, sulphureous, and metalliferous matters, appears, 1. From the subterranean fires in those inferior strata, which produce volcanoes, and probably earthquakes, as Mr Mitchell ingeniously conjectures. 2. From the observation, that all kinds of mountains are not equally metalliferous; but that veins especially are only found in those mountains which, being composed of very ancient strata, are called *primeval*, which form the chains and extensive ridges on the surface of the earth, which direct the course of the waters, and which consist of certain strata, the thickness of each of which, its generic qualities, and its position relatively to the other strata, are, in different parts of the chain of mountains where that stratum is found, nearly uniform and alike, notwithstanding that the numbers and the inclinations of the strata composing contiguous mountains, or even different parts of the same mountain, are often very various; and therefore that veins are seldom, if ever, found in the mountains called by authors *diluvial* and *temporary*, which are single, or detached, which consist not of strata uniformly disposed, but of alluvial masses, in which fragments of ores may be sometimes, but veins never, found. Nevertheless, single and seemingly detached mountains, in small islands, have sometimes been found to be metalliferous. But we must observe, that these mountains consist of uniform strata; that islands themselves, especially small islands, may be considered as eminent parts of sub-marine ranges of mountains, and that the mountains of such islands may be considered as apices or tops only of inferior mountains.

Those mountains are said to be most metalliferous which have a gentle ascent, a moderate height, and a

broad basis, the strata of which are nearly horizontal, and not much broken and disjoined. In these mountains at least the veins are less interrupted, more extended, and consequently more valuable to miners, than the veins in lofty, craggy, irregular, and shattered mountains.

Authors dispute concerning the time in which ores have been formed; some referring it to the creation of the world, or to the first subsequent ages; and others believing that they have been gradually from all times, and are now daily, formed. From the accretion of ores and of their matrices to their proper rocks, and from the insertion of metalliferous nodules and strize in the hardest bones, we are inclined to believe that the matter of these veins and nodules are nearly coeval with the rocks and bones in which they are enveloped. Nevertheless, we cannot doubt that small quantities at least of ores are still daily formed in veins, fissures, and other subterranean cavities. Several well-attested instances confirming this opinion are adduced by authors: Cronstedt mentions an incrustation of silver-ore that was found adhering to a thin coat of lamp-black or of soot, with which the smoke of a torch had soiled a rock in a mine at Koningsberg in Norway; and that this incrustation of silver-ore had been formed by a metalliferous water passing over the rock. Lehman affirms, that he possesses some silver-ore attached to the step of a ladder found in a mine in Hartz, which had been abandoned 200 years ago; and that several steps of ladders similarly incruited had been found. Many other instances are mentioned by authors, of galena, pyrites, silver-ores, and other metalliferous substances, having been found adhering to wood, to fossil-coal, to stalaetical incrustations, to oyster-shells, and other recent substances. From these, and from similar instances, it is probable, that not only ochres and fragments of ores may, with other alluvial matters, be now daily deposited, but also that small quantities of mineralized ores are recently formed; although many histories mentioned by Becher, Barba, Henckel, and other authors, of the entire renovation of exhausted veins, and especially those of the growth and vegetation of metals and of ores, appear to be at least doubtful.

Various opinions have been published concerning the formation of mineralized ores. According to some, these ores were formed by congelation of the fluid masses found in mines, called *Gubrs*. Other authors believe, that ores have been formed by the condensation of certain mineral, metallic, sulphureous, and arsenical vapours, with which they suppose that mines abound. Some have even affirmed, that they have seen this vapour condense, and become in a few days changed into gold, silver, and other metallic matters. It has been above observed, that from several appearances which occur in veins, there is great reason to believe, that ores have not been carried thither and deposited in their present state, but have been there *concreted* and *crystallized*; that is, changed from a fluid to a solid state. But the fluidity of the metalliferous matters at the time of their entrance into veins, may have been occasioned either by their having been *dissolved in water*, if they were capable of such solution, or by their having been raised in form of *vapour* by subterranean fires. For the disposition to crystallize

is acquired by every homogeneous substance that is fluid, whether it has received its fluidity by being melted by fire, or by being dissolved in a liquid menstruum, or by being reduced to the state of vapour. Thus crystals of sulphur have been observed to be daily formed by the sulphureous vapours which exhale in the neighbourhood of volcanoes. The volatility of the two mineralising substances sulphur and arsenic, and the power which volatile bodies possess of elevating a certain portion of any fixed matter which happens to be united with them, render it probable, that the greatest part at least of mineralised ores have been formed of vapours exhaled from subterranean fires, through the cracks in the intervening strata occasioned by those earthquakes which have, in a singular manner, broke and deranged the strata of metalliferous countries, and which, as has been above remarked, have been probably occasioned by, at least have certainly been always accompanied with, subterranean fires.

### SECT. III. *Of the Pyrites.*

PYRITE is a mineral resembling the true ores of metals, in the substances of which it is composed, in its colour or lustre, in its great weight, and, lastly, in the parts of the earth in which it is found, since it almost always accompanies ores. It is, like ores, composed of metallic substances, mineralized by sulphur or by arsenic, or by both these matters, and of an unmetallic earth intimately united with its other principles.

Notwithstanding the conformity of pyrites with ores properly so called, some chemists and metallurgists distinguish the former from the latter minerals; because the proportion and connection of the materials composing the pyrites differ much from those of ores. Thus, although sometimes pyrites contains more metal than some ores, yet generally it contains less metal, and a larger quantity of mineralizing substances, sulphur and arsenic, and particularly of unmetallic earth. The connection of these matters is also much stronger in pyrites than in ores, and they are accordingly much harder; so that almost every pyrites can strike sparks from steel.

From the above property of striking sparks from steel they have been called *pyrites*; which is a Greek word signifying *fire-stone*. Pyrites was formerly used for fire-arms, as we now use flints; hence it was called *carabine-stone*. It is still named by some *marcasite*. Perhaps no other kind of natural body has received so many names. Persons curious to know the other names less used than those we have mentioned, may find them in *Henckel's Pyritologia*. We think, with that celebrated chemist, that the subject has been perplexed by this multiplicity of names; for before his great and excellent work, the notions concerning pyrites were very confused and inaccurate.

Pyrite differs also from ores by its forms and positions in the earth. Although pyritous metals generally precede, accompany, and follow veins of ores; they do not, properly speaking, themselves form the oblong and continued masses called *veins*, as ores do; but they form masses sometimes greater and sometimes smaller, but always distinct from each other. Large quantities of them are often found unaccompanied by ores. They are formed in clays, chalks, marles, marbles, pla-

sters, alabasters, slates, spars, quartz, granites, crystals, in a word, in all earths and stones. Many of them are also found in pit-coals and other bituminous matters.

Pyrites is also distinguishable from ores by its lustre and figure; which is almost always regular and uniform, externally or internally, or both. Some ores indeed, like those of lead, many ores of silver, and some others, have regular forms, and are in some manner crystallized; but this regularity of form is not so universal and so conspicuous in ores as in pyrites. The lustre of pyrites seems to be caused by its hardness, and the regularity of its form by the quantity of mineralizing substances which it contains.

By all these marks we may easily, and without analysis, distinguish pyrites from true ores. When we see a mineral that is heavy, possessed of metallic lustre, and of any regular form, the mass of which appears evidently to be entire, that is, not to have been a fragment of another mass, and which is so hard as to be capable of striking sparks from steel, we may be assured that such a mineral is a pyrites, and not an ore.

The class of pyrites is very numerous, various, and extensive. They differ one from another in the nature and proportions of their component parts, in their forms, and in their colours. The forms of these minerals are exceedingly various. No solid, regular or irregular, can easily be conceived, that is not perfectly imitated by some kind of pyrites. They are spherical, oval, cylindrical, pyramidal, prismatical, cubic; they are solids with 5, 6, 7, 8, 9, 10, &c. sides. The surface of some is angular, and consists of many bases of small pyramids; while their substance is composed of these pyramids, the points of which all unite in the centre of the mass.

Pyritous minerals differ also in their component substances. Some of them are called *sulphureous*, *martial*, *cupreous*, *arsenical*, as one or other of these substances predominate. We must observe with Henckel, whose authority is very great in this subject, that in general all pyrites are martial; as ferruginous earth is the essential and fundamental part of every pyrites. This earth is united with an unmetallic earth, with sulphur or arsenic, or with both these matters; in which case, the sulphur always predominates over the arsenic, as Henckel observes. He considers these as the only essential principles of pyrites; and believes that all the other matters, metallic or unmetallic, which are found in it, are only accidental; amongst which he even includes copper, although so much of it exists in some kinds of pyrites, that these are treated as ores of copper, and sometimes contain even 50th. of copper each quintal. Many other metals, even gold and silver, are sometimes combined in pyrites; but these are less frequent, and the precious metals always in very small quantities; they are therefore justly to be considered as accidental to pyrites. The different substances composing pyrites sensibly affect its colours. Henckel distinguishes them in general into three colours, white, yellowish or a pale yellow, and yellow. He informs us, that these three colours are often so blended one with another, that they cannot be easily distinguished unless when compared together.

The white pyrites contain most arsenic, and are similar to cobalt and other minerals abounding in arsenic. The Germans call them *spickel* or *mispick*. Iron and

Of Pyrites. and arsenic form the greatest part of this pyrites. As arsenic has the property of whitening copper; some pyritous minerals almost white, like that of Chemnitz in Misnia, are found to contain 40 pounds of copper per quintal, and which are so much whitened by the arsenic, that they are very like white pyrites. But Henckel observes, that these pyritous matters are very rare, and are never so white as the true white pyrites, which is only ferruginous and arsenical.

Yellowish pyrites is chiefly composed of sulphur and iron. Very little copper and arsenic are mixed with any pyrites of this colour, and most of them contain none of these two metallic substances. This is the most common kind of pyrites: it is to be found almost every where. Its forms are chiefly round, spherical, oval, flattened, cylindrical; and it is composed internally of needles or radii, which unite in the centre, or in the axis of the solid.

Yellow pyrites receives its colour from the copper and sulphur which enter into its composition. Its colour, however, is inclined to a green; but is sufficiently yellow to distinguish it from the other two kinds of pyrites, particularly when they are compared together. To make this comparison well, the pyrites must be broken, and the internal surfaces must be placed near each other. The reason of this precaution is, that the colour of minerals is altered by exposure to the air.

Persons accustomed to these minerals can easily distinguish them. The chief difficulty is, to distinguish white pyrites from cobalt and other minerals; which also contain some copper and much arsenic.

Hence then we see, that arsenic is the cause of whiteness in pyrites, and is contained in every pyrites of that colour; that copper is the principal cause of the yellow colour of pyrites; and that every pyrites which is evidently yellow contains copper; that sulphur and iron produce a pale-yellow colour, which is also produced by copper and arsenic; hence some difficulty may arise in distinguishing pyrites by its colours. We may also observe, that sulphur and arsenic, without any other substance, form a yellow compound, as we see from the example of orpiment or yellow arsenic. Thus, although the colours of the pyrites enable us to distinguish its different kinds, and to know their nature at first sight, particularly when we have been accustomed to observe them; yet we cannot be entirely certain concerning the true nature of these minerals, and even of all minerals in general; that is, to know precisely the kinds and proportions of their component substances, but by chemical analysis and decomposition.

Besides the above-mentioned matters which compose pyrites, it also contains a considerable quantity of unmetallic earth; that is, an earth which cannot by any process be reduced to metal. Henckel, Cramer, and all those who have examined this matter, mention this earth, and prove its existence.

We ought to observe, that this earth is combined with the other principles of the pyrites, and not merely interposed betwixt its parts. It must therefore be distinguished from other earthy and stony matters mixed accidentally with pyrites, and which do not make a part of the pyrites, since they may be separated by mechanical means, and without decomposing that mineral: but the earth of which we now treat is intimately united with the other constituent parts of the

pyrites, is even a constituent part of pyrites, and essential to the existence of this mineral, and cannot be separated but by a total decomposition of it.

According to Henckel, this unmetallic earth abounds much in the white pyrites, since he found from the analyses which he made, that the iron, which is the only metal existing in these pyrites, is only about  $\frac{1}{2}$ th part of the fixed substance that remains after the arsenic has been expelled by torrefaction or sublimation.

A much larger quantity of iron is in the pale-yellow pyrites, according to Henckel. The proportion of iron is generally about twelve pounds to a quintal of pyrites, and sometimes 50 or 60 pounds: this is therefore called *martial pyrites*. It contains about  $\frac{1}{2}$  of its weight of sulphur, and the rest is unmetallic earth.

The quantity of unmetallic earth contained in the yellow or cupreous pyrites, which are also martial, since, as we have observed, iron is an essential part of every pyrites, has not yet been determined. They probably contain some of that earth, tho' perhaps less of it than the others.

The nature of this unmetallic earth of pyrites has not been well examined. Henckel thinks that it is an earth disposed already by nature to metallization, but not sufficiently elaborated to be considered as a metallic earth. This opinion is not improbable; but as alum may be obtained from many pyrites, may we not suspect that this unmetallic earth is of the nature of the basis of alum or argillaceous earth? Perhaps also this earth is different in different kinds of pyrites. The subject deserves to be well examined.

Although pyrites is not so valuable as true ores, because in general it contains less metal, and but exceedingly little of the precious metals; and because its metallic contents are so difficult to be extracted, that, excepting cupreous pyrites, which is called *pyritous copper ore*, it is not worked for the sake of the contained metal; yet it is applied to other purposes, and furnishes us with many useful substances; for from it we obtain all our green and blue vitriols, much sulphur, arsenic, and orpiment. See the principal processes by which these substances are extracted from pyrites, under the section SMELTING OF ORES.

As all pyrites contain iron, and most of them contain also sulphur; as the pyrite most frequently found contains only these two substances with the unmetallic earth; and as iron and sulphur have a singular action upon each other when they are well mixed together and moistened; hence many kinds of pyrites, particularly those which contain only the principles now mentioned, sustain a singular alteration, and even a total decomposition, when exposed during a certain time to the combined action of air and water. The moisture gradually penetrates them, divides and attenuates their parts; the acid of the sulphur particularly attacks the martial earth, and also the unmetallic earth, its inflammable principle is separated from it, and is dissipated. While these alterations happen, the pyrites changes its nature. The acid of the sulphur which is decomposed, forms with the fixed principles of the pyrites, vitriolic, aluminous, and selenitic salts; so that a pyrites, which was once a shining, compact, very hard mineral, becomes in a certain time a greyish, saline,



Of *Pyrites*, line, powdery mass, the taste of which is saline, austere, and styptic.

Lastly, if this mass be lixiviated with water, crystals of vitriol, and sometimes of alum, according to the nature of the pyrites employed, may be obtained by evaporation and crystallization.

This alteration and spontaneous decomposition of pyrites, is called *efflorescence* and *vitriolization*; because the pyrites become covered with a saline powder, and because vitriol is always formed. This vitriolization is more or less quickly accomplished in pyrites according to its nature. It is a kind of fermentation excited by moisture amongst the constituent parts of these minerals; and it is so violent in those which are most disposed to it, that is, in the pale-yellow pyrites, which contain chiefly sulphur and iron, that when the quantity of these is considerable, not only a sulphureous vapour and heat may be perceived, but also the whole kindles and burns intensely. The same phenomena are observable, and the same results are formed, by mixing well together, and moistening a large quantity of filings of iron and powdered sulphur; which experiment Lemeris has made, to explain the causes of subterranean fires and volcanos.

We cannot doubt that, as the earth contains very large masses of pyrites of this kind, they must undergo the same changes when air and moisture penetrate the cavities containing them; and the best natural philosophers agree, that very probably this surprising decomposition of pyrites is the cause of subterranean fires, of volcanos, and of mineral waters, vitriolic, aluminous, sulphureous, hot and cold.

No other pyrites is subject to this spontaneous decomposition when exposed to humid air, but that which is both martial and sulphureous; that is, the pale-yellow pyrites. The arsenical pyrites, or that which contains little or no sulphur, is not changed by exposure to air. This latter kind is harder, heavier, and more compact, than the former. The pyrites which is angular and regularly shaped, is chiefly of this kind. Mr Wallerius, in his Mineralogy, proposes to distinguish this kind of pyrites by the name of *marcastite*. When cut, it may be polished so well as to give a lustre almost equal to that of diamonds, but without refracting or decomposing the light; for it is perfectly opaque. It has been employed some years past in the manufacture of toys, as of buckles, necklaces, &c. and is called in commerce *marcastite*.

We cannot, however, concur with Mr Macquer, (from whom the above is taken), in thinking that there is sufficient reason for considering the minerals called *pyrites*, as a distinct class of substances from ores. They have indeed no mark by which they can certainly and constantly be distinguished from these. The hardness or property of striking ignited sparks from steel is not common to all the substances generally called *pyrites*; for we find some of these enumerated by mineralogists which have not that property. Wallerius even mentions a pyrites which contains no iron, altho' that metal is thought by Henckel to be essential to pyrites. The distinction of pyrites from ores has been chiefly introduced by miners; because the greatest part of the former minerals contain so little metal, and so much of the mineralizing substances, sulphur, or arsenic, that they are seldom smelted. Nevertheless, some

kinds of pyrites are found which contain so much copper, that they are smelted with great profit. Accordingly, some later mineralogists consider the cupreous yellow pyrites as an ore of copper, the pale-yellow martial pyrites as an ore of iron; and the white arsenical pyrites as an ore of arsenic. See *ORES of COPPER, IRON, and of ARSENIC, infra*.

#### SECT. IV. *Effaying of Ores in general.*

ESSAYS are chemical operations made in small, to determine the quantity of metal or other matter which is contained in minerals; or to discover the value or purity of any mass of gold or silver. The former kind is the subject of the present section; the latter is treated under the word *ESSAYS*, in the order of the alphabet.

Before essays of ores can be well made, a preliminary knowledge of the nature of the several metallic minerals ought to be attained. Each metal has its proper and improper ores, which have peculiar characters and appearances; hence persons accustomed to see them, know pretty nearly, by the appearance, weight, and other obvious qualities, what metal is contained in a mineral. A good essayer ought to be very intelligent in this matter, that he may at once know what the proper operations are which are requisite to the essay of any given mineral.

As metals are very unequally distributed in their ores, we should be apt to make false and deceitful essays, if we did not use all possible precautions that the proportionable quantity of metal produced by an essay shall be nearly the medium contained in the whole ore. This is effected by taking pieces of the mineral from the several veins of the mine if there be several, or from different places of the same vein. All these minerals are to be shook together with their matrices. The whole is to be well mixed together, and a convenient quantity of this mixture is to be taken for the essay. This is called the *lotting* of the ore.

As essays, particularly the first, are generally made in small, essays have very small weights corresponding to the weights used in the great; that is, to the quintal or hundred pounds weight, to pounds, ounces, drama, &c. The essay quintal and its subdivisions, vary according to the difference of weights in different countries; and this occasions some confusion, when these weights are to be adjusted to each other. Tables of these weights are found in treatises of essaying; and particularly in that written by Schlutter, and translated and rendered more complete by Hellot, which contains all the details necessary for the subject.

The custom is to take, for the essay quintal, a real weight of a gros, or dram, which in France is equal to 72 grains; but as the whole dram represents 100 pounds, each grain represents a pound and a fraction of a pound; and hence some difficulty and confusion arise in making the subdivisions. A better method is that of Mr Hellot, which is to make the fictitious or essay quintal equal to 100 real grains, and then each grain represents a real pound. This essay quintal is sufficiently exact for ores of lead, tin, copper, iron, antimony, bismuth, and mercury. But for ores of silver and gold, another representation is convenient: for these metals, as Mr Hellot says, are generally in so small quantity, that the button or small piece of metal

Effaying of Ores. obtained in the essay could not be accurately weighed if 100 real grains were made to represent a quintal; and the difficulty of separating the gold from so small a quantity would be still greater. These motives have induced Mr Hellot to use for these ores a fictitious quintal 16 times bigger; that is, equal to 1600 real grains, which represent 1600 ounces; that is, 100lb. or quintal. The ounce being represented by a grain, its several subdivisions must be represented by fractions of a grain. Thus 12 grains of the fictitious quintal correspond with  $\frac{1}{12}$  of a real grain (B); and this latter quantity may be accurately weighed in essay-balances, which when well made are sensible to a much less weight. See (*Essay*) BALANCE.

When a quintal of an ore to be essayed has been weighed, and lotted, and as we described above, it is to be roasted in a test under a muffle. It is to be washed, if necessary; and, in short, the same operations are to be made in small which are usually done in great. Additions also are to be made, and in proper proportions, according to the peculiar nature of the ore. The fluxes generally mixed with the ore in essays are three, four, or five parts of black flux; one, two, or three parts of calcined borax; and one half of that quantity of decrepitated common salt. The more refractory the ore is, the more necessary is the addition of these fluxes: then the whole mixture is to be fused either in a forge, or in a melting or essay furnace.

To make essays well, all possible attention and accuracy are to be employed. This object cannot be too much attended to; for the least inaccuracy in weighing, or loss of the smallest quantity of matter, might cause errors, so much greater, as the disproportion betwixt the weights employed and those represented is greater. The most minute accuracy therefore is necessary in these operations. For instance, the essay-balances ought to be small, and exceedingly just. The ore ought not to be weighed till it has been reduced to gross powder fit for roasting; because some of it is always lost in this pulverization. When the ore is roasted, it ought to be covered with an inverted test; because most ores are apt to crackle and disperse when first heated. To make the fusion good and complete, the precise degree of fire which is requisite ought to be employed; and when it is finished, the crucible ought to be struck two or three times with some instrument, to facilitate the disengagement of the parts of the regulus from the scoria, and to occasion their descent and union into one button of metal. The crucible ought not to be broken, nor its contents examined, till it is perfectly cold.

Upon breaking the crucible, we may know that the fusion has been good, if the scoria be neat, compact, and equal; if it has not overflowed or penetrated the crucible; if it contain no metallic grains; and if its

surface be smooth, and hollowed in the middle. The regulus or button ought to be well collected, without holes or bubbles, and to have a neat convex surface; it is then to be separated from the scoria, well scraped and cleaned; and, lastly, is to be weighed. If the operation has been well made, its weight shews the quantity of metal which every real quintal of ore will yield in the great. If the perfect success of this essay be in any respect doubtful, it ought to be repeated; but the best method at all times is, to make several essays of the same ore. Some small differences are always found, however well the essays may have been made. By taking the medium of the results of the several operations, we may approach as nearly as possible the true product of the ore.

Lastly, as mines are not worked, nor founderies established (which cannot be done without considerable expense), till the ore has been essayed, ten or twelve real pounds of the ore ought to be previously essayed; and essayers ought to be furnished with necessary furnaces and instruments for these larger essays.

In Part II. to the several articles of the ores of metals, we shall add the most approved methods of essaying these ores. We shall here only further observe in general, that the methods commonly practised for essaying ores of imperfect metals, and semimetals especially, are insufficient to procure the whole quantity of metal contained in ores, or even so much as is obtained in the smelting of large quantities of ores; and that therefore the result of essays is not to be considered as the precise quantity contained in an ore, but generally only as an inaccurate approximation to that quantity. M. Gellert ascribes one cause of the want of success of these operations to the alkaline salts employed as fluxes to the ores, by which most metallic calxes are partially soluble, but more especially so when any of the sulphur of the ore remains; which, by uniting with these salts, forms a hepar of sulphur which is the most powerful of all solvents. He proposes therefore to omit the black flux, and other alkaline salts, and to add nothing to the ore but powder of charcoal, and some fusible glass. This method, he says, he learned from Mr Cramer, and has himself used with much success in the essays of iron and copper: but finding that other imperfect metallic substances could not sustain the heat necessary to effect the fusion and vitrification of the unmetallic parts of the ore without being partly dissipated, he found it necessary to add in the essays of these latter metallic matters some borax, by which the fusion might be completed with less heat. As we consider this as a considerable improvement in the art of essaying ores, we shall, to the articles of the several ores, add not only the processes commonly prescribed, but all those of Mr Gellert, according to the method here mentioned.

## PART

(B) The pounds, of which 100 is here supposed to make a quintal, are called *Paris pounds*, one of which contains 1269 Troy grains.

## P A R T II.

Containing a summary description of the principal Ores of each Metal, and the methods of Effaying them.

SECT. I. *Ores of Gold.*

§ 1. PROPERLY speaking, no ores of gold exist: for as this metal cannot be alloyed with arsenic, nor with sulphur, it is never found directly mineralised by these substances, as the other metals are. In the second place, if it be mineralised indirectly by the union it contracts with other metals naturally combined with sulphur and arsenic, so small a quantity of it only is found in these ores, that they scarcely even deserve the name of *improper ores of gold*.

Hence gold is found either in its natural state, of a certain degree of purity, possessed of all its properties; or engaged with some other metals in certain minerals.

The gold which is found alone is called *native* or *virgin gold*. This is generally incrusted, and fixed in different kinds of stones, principally in flints and quartz. Mr Cramer says, that the yellow brilliant spots of the blue stone, called *lapis lazuli*, are native gold; but these are very small.

Gold is also found in fat and muddy earths; and Mr Cramer affirms, that scarcely any fat can be found which does not contain gold; but he acknowledges, at the same time, that the quantity is too small to compensate for the expence of obtaining it.

Lastly, the largest quantity of native gold is to be found in the sands of some rivers. It is chiefly collected in hollows at the bottom of these rivers, and at their several bendings. The gold is collected in these places by a natural operation, similar to that of washing of ores.

A considerable quantity of gold is in the sand of several rivers in France: so that persons who collect it find enough to compensate their trouble. Mr Reaumur, in a memoir that he gave in the year 1718 concerning the rivers of France which contain gold, enumerates ten of them; namely, the Rhine, the Rhone, the Doux, the Ceze, and the Gardon; the Arriege; the Garonne; two streams which flow into the Arriege, called *Ferriet* and *Benagues*; lastly, the Salat, the source of which is in the Pyrenean mountains.

The Ceze is the river which furnishes the largest quantity of gold at certain times. Mr Reaumur observes, that its particles are larger than those of the Rhine and of the Rhone; and says, that in some days a peasant will find gold to the value of a pitole, and in others will scarcely find any.

The native gold found in rivers or elsewhere is never perfectly pure, or of twenty-four karats. It always contains a certain quantity of alloy, which is generally silver. The gold of the French rivers, according to Mr Reaumur's trials, was found to be from eighteen to twenty-two karats, that of the Ceze being the lowest, and that of the Arriege being the purest.

Although gold, however, as above observed from

Macquer, cannot be directly dissolved by sulphur, yet it probably may be mineralised by the intervention of other metallic matters. Thus, although no proper ore of gold exists, yet it is found in several mineral substances, in which it is always accompanied, as Cramer affirms, with a much larger quantity of silver; to which latter metal that author attributes its mineralised state. The minerals containing gold are blend, cupreous and arsenical pyrites, ore of antimony, cinnabar, white ore of arsenic, vitreous and other silver ores, and the lead-ore called *galena*.

Gold is more frequently imbedded in quartz than in any other matrix, but it is also found in limestone and in hornblend. Gold mines are in general very precarious, as they do not form regular veins, nor is the gold uniformly distributed through a matrix.

Becher and Cramer think, that no sand is entirely free from gold. The yellow, red, black, and violet-coloured ferruginous sands, are said to contain most gold. Mr Hellot relates, that in a eleven assays of one kind of sand, from a quintal, or 921,600 grains, were obtained each time from 848 to 844 grains of noble metal, exclusive of the gold which remained in the scoria; and that of the metal thus obtained two thirds were gold, and the remaining third was silver. He says, that parcels of sand taken up at very small distances from each other contained very unequal proportions of gold.

The gold found in sands is generally less pure than that which is imbedded in a solid matrix. Reaumur says, that a piece of gold, weighting 448 ounces, was shewn to the Royal Academy at Paris, which was found upon assay to have different fineness in different parts of the mass.

§ 2. *Ores and earths containing gold may be assayed* by the methods directed for the extraction of gold from large quantities of these auriferous matters, (see Part II.): or they may in general be assayed by being fused in a cupel or test, placed under the muffle of an assay-furnace, or in a crucible placed in an air-furnace, with eight or ten times their quantity of lead if they be easily fusible, and with a larger quantity of lead if they be difficultly fusible; and by scorifying the earthy matters, while the lead becomes impregnated with the noble metals. These operations are entirely similar to those employed for the separation of silver from its ores by precipitation with lead; a detail of which see subjoined under the section ORES OF SILVER, [Processes I. III. IV. V. VI.]. These metals are afterwards to be separated from the lead by cupellation, in the manner directed in the article ESSAY (of the value of silver and of gold). The gold is then to be separated from the silver by the processes described in the article PARTING.

The quantity of lead to be added to the ore in this assay must be such as renders the scoria very thin, that the whole gold may be imbibed by the lead. Some iron ores containing gold cannot be reduced into

Platina and  
Silver.

into a scoria sufficiently thin with sixteen times their quantity of lead unless the heat be at the same time considerably increased. When the ore is exceedingly refractory, the scorification ought to be promoted by adding to it four times its quantity of tartar, twice its quantity of nitre, and four times its quantity of litharge. This mixture is to be put in a good essay-crucible, and covered with the sea-salt. The crucible is to be set in a forge-heap, and exposed gradually to heat, till the scoria has acquired sufficient fluidity, and the lead has imbibed the noble metal.

See the methods which have been used for assaying auriferous sands, under Part III.

### SECT. II. Ores of Platina.

PLATINA is very rare, and has been but lately discovered. As, like gold, it cannot be alloyed with sulphur or with arsenic, probably no ore, properly so called, exists of this metal. Accordingly in the only mines of platina which we know, namely, the gold mines of Santafe near Carthage, the platina is found native like the gold, and in its metallic state.

### SECT. III. Ores of Silver.

§ 1. NEXT to gold, silver is the metal most frequently found in its metallic state, that is, not mineralized by sulphur or by arsenic. This silver, called also *native* or *virgin*, generally affects some regular form, and consists of filaments or vegetations of various figures. It is found in form of plates, of fibres, or of grains, or crystallized. It lies generally in quartz, flint, spar, slate, cobalt, and in silver-ores. It is sometimes enveloped in a thin stony crust. It is generally alloyed with some gold: but silver, like all the other metals, is much more frequently found mineralized by sulphur and by arsenic.

Three principal proper ores of silver are known, which are very rich, but very rare. These are;

1. The *vitreous silver ore*. This ore has no determinate figure, and has nearly the colour, softness, and fusibility of lead. It is very heavy, and contains three quarters of its weight of pure silver. In this ore the silver is mineralized by sulphur alone. Some expert artists imitate it very well by combining sulphur with silver by fusion in a crucible.

This ore, according to Cronstedt, is either in form of plates or of fibres, or is crystallized, or has no determinate figure. It may be imitated by adding about five parts of sulphur to one part of melted silver; in which operation most of the sulphur is consumed: or it may be imitated by exposing a plate of silver red-hot to the fumes of burning sulphur.

2. The *horny or corneous silver ore*. This ore is so called from its colour and semitransparency, by which it resembles horn or colophony. This ore, being suddenly heated, crackles, as almost all ores do, and melts with a gentle heat. Two-thirds of it are silver, which is mineralized by sulphur and arsenic. This ore is very rare. Wallerius says, after Woodward, that it is found at Johaun-Georgen-Stadt in Saxony.

*Corneous ore* has various colours; white, pearly, brown, yellow, greenish, or reddish. It is foliated and semitransparent. It is somewhat ductile, and fusible with the flame of a candle. When heated, it emits, as Wallerius says, a sulphureous and blue flame,

and, according to Cramer, also a very small quantity of an arsenical fume. Wallerius says, that it contains two-thirds of silver, with a considerable quantity of sulphur, and a small quantity of arsenic. Lehman thinks that it is silver united with a little arsenic. But Mr Cronstedt says, that it is a luna cornea, or silver combined with marine acid; and that it is incapable of being decomposed but by substances which can unite with that acid. This latter opinion seems to be the most probable; as the ore, according to its description, is similar to luna cornea, and as it cannot be imitated by any mixture of sulphur and of arsenic with silver. The blue flame, and the smell slightly arsenical, which are emitted from heated corneous ore, are also observable from every combination of marine acid with a substance containing phlogiston.

3. *Red silver ore*, called also *reficlaré*. Its colour is more or less red; it is sometimes crystallized, very heavy, and is fusible like the above-mentioned ores. In this ore the silver is mineralized by arsenic and by sulphur, but chiefly by the former. It also contains a little iron, and furnishes two-thirds of its weight of silver. Its red colour may proceed either from the iron it contains; or from the mixture of arsenic and sulphur; or, lastly, from the particular manner in which the arsenic is united with the silver, an example of which we have in the red precipitate of silver made by the neutral arsenical salt.

*Red silver ore* is either plated or solid, or crystallized, and frequently semitransparent. Its colour is various, from a dark grey to a deep red, according to the proportions of the two mineralising substances. It crackles and breaks in the fire, exhales an arsenical fume, and is readily fused. It is found generally in quartz, spar, crystal, hornblend.

Besides the three silver ores above described, the following ores contain silver mixed with other metals.

1. *Grey silver ore*. This contains copper and silver mineralized by arsenic and sulphur, and generally more of the former than of the latter metal; but as it is valued chiefly for the silver, it has been generally enumerated amongst silver ores.

2. *White silver ore* is an arsenical pyrites containing silver.

3. *Black silver ore* contains sulphur, arsenic, copper, iron, sometimes lead, and about a fourth part of silver, according to Wallerius.

4. *Plumose silver ore* is white or black, striated like plum-alum, or like ore of antimony. It is silver mineralized by sulphur, arsenic, and antimony.

5. *Pech-blend*. In this blend silver, gold, and zinc, are mineralized by sulphur, probably by intervention of iron, by which the gold and zinc are rendered capable of uniting with the sulphur.

6. Silver is frequently found in *galena*; and sometimes in *martial pyrites*; in the *red ore of arsenic*; in various ores of copper, lead, tin, iron, and especially cobalt; in blends; in yellow or red earthen; in black and blue basaltes; and also in strata of stones which do not appear externally to contain any mineral substance.

7. *Liquid silver ore*, or *gubr of silver*, is a grey or whitish liquid mass, which contains, as Wallerius says, either native silver, or some fluid substance capable of producing it. Mr Cronstedt mentions, in the Swedish

Ores of  
Silver.

*Effaying*  
of Ores of  
Silver.

Effaying of Norway containing silver. Another instance is also mentioned of a silver guhr, in the *Act. Erud. Upsal.* 1720.

8. Mr Von Justi pretends, that he has found silver mineralized by an *alkaline substance*; but he has not spoken sufficiently distinctly concerning it, to know whether he means a saline or earthy alkaline matter. Henckel also pretends, that by treating calcareous earth or certain clays with pyrites, silver may be obtained.

§ 2. *Ores of silver may be essayed* by the same methods which are employed for the extraction of that metal from large quantities of ores; which methods are different, and suited to the different qualities of the different ores. See Part III. Or, in general, ores and earths containing silver may be essayed by the following processes, which are copied from Dr Mortimer's English edition of *Cramer's Art of Essayng Metals*, Part II. *Process 1.*

## P R O C E S S I.

*To precipitate Silver by means of Lead from fusible Ores.*

“ POUND the ore in a very clean iron mortar into fine powder: of this weigh one decimathical centner or quintal, and eight of the like centners of granulated lead.

“ Then have at hand the decimathical test, which must not as yet have served to any operation: pour into it about half of the granulated lead, and spread it with your finger thro' the cavity of it.

“ Put upon this lead the pounded ore; and then cover it quite with the remainder of the granulated lead.

“ Put the test thus loaded under the muffle of an essay-furnace, and in the hinder part of it: then make your fire, and encrease it gradually. If you look thro' the holes of either of the sliders, you will soon see that the pounded ore will be raised out of the melted lead, and swim upon it. A little after, it will grow clammy, melt, and be thrown towards the border of the test: then the surface of the lead will appear in the middle of the test like a bright disc, and you will see it smook and boil: so soon as you see this, it will be proper to diminish the fire a small matter for a quarter of an hour; so that the boiling of the lead may almost cease. Then again, increase the fire to such a degree, that all may turn into a thin fluid, and the lead may be seen, as before, smoking and boiling with great violence. The surface of it will then diminish by degrees, and be covered over with a mass of scorias. Finally, have at hand an iron hook ready heated, wherewith the whole mass must be stirred, especially towards the border; that in case any small parcels of the ore not yet dissolved should be adherent there, they may be brought down, taking great care not to stir any the least thing out of the test.

“ Now, if what is adherent to the hook during the stirring, when you raise it above the test, melts quickly again, and the extremity of the hook grown cold is covered with a thin, smooth, shining crust; it is a sign that the scorification is perfect; and it will be the

more so as the said crust adherent to the hook shall be coloured equally on every side: but in case, while the scorias are stirred, you perceive any considerable clamminess in them, and when they adhere in good quantity to the hook, though red-hot, and are inequally tinged, and seem dusty or rough with grains interspersed here and there; it is a sign that the ore is not entirely turned into scorias. In this case, you must with a hammer strike off what is adherent to the hook, pulverize it, and with a ladle put it again into the test, without any loss or mixture of any foreign body, and continue the fire in the same degree till the scoria has acquired its perfection and the abovementioned qualities. This once obtained, take the test with a pair of tongs out of the fire, and pour the lead, together with the scoria swimming upon it, into a cone made hot and rubbed with tallow. Thus will the first operation of the process be performed, which does not commonly indeed last above three quarters of an hour.

“ With a hammer strike the scorias off from the regulus grown cold, and again examine whether they have the characteristics of a perfect scorification; if they have, you may thence conclude, that the silver has been precipitated out of the ore turned to scorias, and received by the lead.

“ When the scorification lasts longer than we mentioned, the lead at last turns to scorias or litharge, and the silver remains at the bottom of the vessel: but the fire must be moderately supplied, and the vessels be extremely good, to produce this effect; for they seldom resist to the strength of the scorias long enough; so that the whole scorification may be brought to an end; which has afterwards this inconveniency, that the silver is dissipated by grains in the small hollows of the corroded ore, and can hardly be well collected again, when the ore has but little silver in it. Nay, there is still more time to be consumed to obtain the perfect destruction of the lead, by means of the combined actions of the fire and air, because the scorias swimming at the top retard it considerably.

“ In this process, the sulphur and the arsenic of the silver-ore, when the ore is broken small, and extended widely in a small quantity, are in part easily dissipated by the fire, and in part absorbed by the lead; the lighter part of which, swimming upon the heavier, becomes very clammy by means of the sulphur which is in the ore; but when this is dissipated by the violence of fire, it turns into glass or scorias: but when arsenic is predominant in the ore, the plumbeous part turns immediately into a very penetrating and very fusible glass, having a dissolving efficacy, unless the arsenic lies hidden in a white pyrite or cobalt. For this reason, the fixed part of the ore, which is no silver, is dissolved by that glass, melts, and assumes the form of scorias. The unmetallic earths and the pure copper or lead ores thereto adherent are of this kind. The silver then remains immutuable; and being freed of these heterogeneous bodies, which are partly dissipated and partly melted, it is precipitated and received by the remaining regulus of lead. Therefore this process is completed by three distinct operations; viz. 1. By roasting. 2. By scorification. 3. By the melting precipitation of the silver, which is the result of the two former operations.

*Effaying*  
of Ores of  
Silver.

"The ore must be pulverised very fine, in order to increase the surface, that the diffipation of the volatiles and the dissolution by litharge may be sooner effected. This pulverising must then be done before the ore is weighed, because there is always some part of the ore adherent to the mortar or iron plate on which it is made fine; which part being lost, the operation is not exact. Erker was in the right when he prescribed eight centners of lead for the subduing of fusible ores. Nevertheless, it must be owned, that this quantity is superfluous in some cases. However, as the fluxibility of the silver-ore depends from the absence of stones, pyrites, &c. it is easy to see, that there are an infinite number of degrees of fluxibility which it would be needless to determine exactly, and most commonly very difficult to determine by the bare sight. Besides, a little more lead does not render the process imperfect; on the contrary, if you use too small a quantity of lead, the scorification is never completely made. Nay, there are a great many ores, containing sulphur and arsenic in plenty, that destroy a considerable quantity of lead: such are the red silver-ore, and that wherein there is a great deal of the steel-grained lead-ore. If the fire must be sometimes diminished in the middle of the process, it is in order to hinder the too much attenuated litharge, which is continually generated out of the lead, from penetrating the pores of the test, and from corroding it; which is easily done when the fire is over-strong; for then the surface of the vessel which is contiguous to the lead contracts cavities, or, being totally consumed by small holes, lets the regulus flow out of it. The vessels that are most subject to this inconvenience are those in the materials of which lime, plaster, and chalk are mixed. Nay, these bodies, which are of their nature refractory, being eroded during their scorification, at the same time communicate a great clamminess to the scoria; so that a great quantity of the mass remains adherent to the test in the form of protuberances, when you pour it out; whereby a great many grains of the regulus are detained."

### P R O C E S S I I.

THE regulus obtained by the process I. contains all the silver of the ore, and the uncorified part of the lead. The silver may be afterwards separated from the lead, and obtained pure by *cupellation*; which process is described under the article *Essay (of the value of Silver.)*

### P R O C E S S I I I.

*If the silver-ore cannot be washed clean, or if it be rendered refractory by a mixture of unmetallic earths and stones, the scorification of these earthy matters frequently cannot be completed by the process I. Cramer therefore directs, that such ores shall be treated in the following manner.*

"Bruise the ore into an impalpable powder, by grinding it in a mortar; to a doctimical center of it, add a like quantity of glass of lead finely pulverised; for the more exactly these two are mixed together, the more easily the scorification afterwards succeeds. Put this mixture, together with 12 centners of lead, into the test, according to process I. then put the test under the muffle.

"Make first under it a strong fire, till the lead boils very well; when you see it so, diminish the violence of the heat, as was directed in the first process; but keep it thus diminished a little longer: then, finally, again increase the fire to such a degree, till you perceive the signs of a perfect scorification and fusion. *See the whole process I.* Now this process lasts a little longer than the foregoing, and requires a greater fire towards the end.

"It sometimes happens that a very refractory ore cannot be dissolved by litharge; and that a mass, which has the clamminess of pitch, swims upon the regulus and upon the scorias themselves which are already subdued in part: when you see this, shut the vents of the furnace to diminish the fire; then gently touch this refractory body with a small iron cold hook, to which it will immediately stick; take it off softly, not to lose any thing; pound it into a fine powder, adding a little glass of lead, and put it again into the test; then continue the scorification till it is brought to its perfection. But you must always examine the scoria of your refractory ore, to see whether there may not be some grains of regulus dispersed in it: for sometimes the scorias that grow clammy retain something of the metal; which if you suspect, pound the scorias into a fine dust, and thus the grains of metal will appear if there are any left, because they can never be pounded fine. The silver is separated from this regulus by cupelling, as in process II.

"All earths and stones are refractory in the fire: for, although some of them melt naturally in the fire, as those that are vitrifiable do; nevertheless, all the others, a very few excepted, melt much more difficultly than metals, and never become so thin in the fusion as is required for the sufficient precipitation of a precious metal. But litharge itself does not conveniently dissolve these refractory matters by the help of fire alone, unless you add some mechanical mixture to them; for the very moment the said litharge penetrates through the interlices of the refractory ore, and begins to dissolve it, a tenacious mass is produced, which hardly admits any farther dilution by the litharge. You may see it plain, if you make coloured glasses with metallic calxes; if you pour carefully upon them a calx that gives a colour, you will never obtain that they may be equally dyed on every side, even although you should torture them for whole days together in a great fire. Nay, glasses already made can never be diluted by only pouring salts and litharge upon it. Wherefore, you must use the artifice of glass-makers, who, in the making of the most perfect glasses, take great care, before they put the species of their ingredients into the fire, to have a mechanical mixture precede, or at least accede during the fusion itself, which is done here by pounding glass of lead mixed with the ore: but if you think that your glass of lead is not sufficiently fusible, you may add to it litharge melted first, and then pounded into a fine powder.

"As this scorification requires a longer and a greater fire than the foregoing, and as a greater quantity of litharge is moreover requisite to subdue the refractory scoria; it is easy to see why a much greater quantity of lead must be used here than in process I.; and, although less lead is often sufficient,

Eflaying  
of Ores of  
Silver.

it is nevertheless proper always to use the greatest quantity that can be necessary; left, for instance, it should be necessary to try for many times the lead alone, to make it evident how much silver the lead when alone leaves in the coppel. Nor need you fear left any thing of the silver be taken away by the lead, provided the coppels be good, and the coppelling duly put in execution: for you can hardly collect a ponderable quantity of silver out of the collected fume of the lead, which rises during the coppelling, as well as out of the litharge that is withdrawn into the coppel."

## P R O C E S S I V.

*If the ore be rendered refractory by pyrites, Cramer directs that the silver should be precipitated by lead in the following manner. (Art of Assaying, Part II. proc. 4.)*

"Break your ore into a rough powder, and put a centner of it into the test: put upon this another test in the manner of a tile; put it under the muffle hardly red-hot: increase the fire by degrees. There will always be a crackling: which being ended, take away the upper-test; for when the vessels have been red-hot about one minute, the ore ceases to split. Leave the ore under the muffle till the arsenic and the sulphur are for the most part evaporated; which you will know from the cessation of the visible smoke, of the smell of garlic, or the acid; then take away the test, and leave it in a place not too cold, that it may cool of itself.

"Pour out, without any dissipation, the roasted ore, and with a knife take away what is adherent to the vessel; pound it to a most subtle powder, and grind it together with an equal weight of glass of lead; and, finally, scorify the whole collected ore in the same test wherein the testing was made, unless it has contracted chinks, as was described in Process III.

"Remarks. Yellow pyrites-ores contain a very great quantity of sulphur, even greater than is necessary to saturate the metal that lies hidden in them. For which reason this superfluous sulphur dissipates in a middling fire; but if it had been mixed with lead, it would have rendered it refractory, nor could it afterwards be dissipated from it without a considerable destruction of the lead. The white arsenical pyrites turn also a great quantity of lead into glass, on account of the abundance of the arsenic they contain. For which reason these ores must be previously roasted, that the sulphur and arsenic may be dissipated. Nor need you fear left any part of the silver be carried away with the arsenic; for when arsenic is separated from any fixed body, by a certain degree of fire, it carries nothing of that body away with it."

## P R O C E S S V.

*SILVER may be precipitated from its ore by cupellation only, in the following Process, given by Cramer, [Art of Assaying, Part II. Proc. 9.]*

"Pound one centner of ore; roast it in the manner directed in the last process; beat it to a most subtle powder; and if it melts with difficulty on the fire, grind it together with one centner of litharge, which is not necessary when the ore melts easily: then

divide the mixture or the powder of the ore alone into five or six parts, and wrap up every one of them severally in fuch bits of paper as can contain no more than this small portion.

"Put a very large coppel under the muffle; roast it well first, and then put into it sixteen centners of lead: when the lead begins to smoke and boil, put upon it one of the said portions with the small paper it was wrapped up in, and diminish the fire immediately, in the same manner as if you would make a scorification in a test, but in a lesser time. The small paper, which turns presently to ashes, goes off of itself, and does not sensibly increase the mass of the scoria. The ore proceeding therefrom is cast on the border, and turns to scoria very soon. Increase the fire again immediately, and, at the same time, put another portion of the ore into the coppel, as was just now said. The same effects will be produced. Go on in the same manner, till all the portions are thrown in and consumed in the lead. Finally, destroy the remaining lead with a stronger fire.

"The silver that was in the ore and in the lead will remain in the coppel. If you deduct from it the lead proceeding from the lead, you will have the weight of the silver contained in the ore. If the ore employed was easy to be melted, all the scoria vanishes; but if it was refractory or not fusible, all the scoria does not always go away, but there remains something of it now and then in the form of dust. A great many ores and metals may be tried in this way, except only such as split and corrode the coppels. There are likewise some of them which must be previously prepared in the same manner as is required to render them fit for going through a scorification. See the foregoing Processes.

"Remarks. The ore thrown at several times upon lead boiling in a coppel may be dissolved without the foregoing scorification: but this is very far from having an equal success with all kinds of ores; for there are ores and metals which resist very much to their dissolution by litharge; and which being on this account thrown on the border, are not sufficiently dissolved; because the litharge steals away soon into the coppel. Nevertheless, there are some others which vanish entirely by this method, except the silver and gold that was contained in them.

"A previous roasting is necessary, first, for the reasons mentioned, and then because the ore thrown upon boiling lead should not crackle and leap out; for, having once passed the fire, it bears the most sudden heat."

## P R O C E S S V I.

*Silver may be precipitated out of the same bodies as were mentioned in the foregoing processes by scorification in a crucible. [Cramer, Proc. 15.]*

"THE body out of which you intend to precipitate silver must be previously prepared for a scorification by pounding and roasting, as mentioned in the former processes. Then, in the same manner, and with the same quantity of lead, put it into a crucible strictly examined, that it be entire, solid, not speckled with black spots, like the scoria of iron, especially at its inferior parts, and capable of containing three times

as much. Add besides glass gill and common salt, both very dry, and enough, that when the whole is melted, the salts may swim at top at the height of about half an inch.

“Put the crucible thus loaded into a wind-furnace; shut it close with a tile; put coals round it, but not higher than the upper border of the crucible. Then light them with burning coals, and increase the fire till the whole melts very thin, which will be done by a middling fire, maintained always equal, and never greater: leave it thus for about one quarter of an hour, that the fcorification may be perfectly made. Take off the tile and stir the mass with an iron wire, and a little after pour it out into the mould. When the regulus is cleaned from scorias, try it in a test by compelling it.

“Remarks. The fcorification of any ore whatever, or of any body fetched out of ores, may indeed be made by this apparatus, as well as in a test under a muffle: but it serves chiefly to the end that a greater quantity of metal may be melted from it with profit. For you may put many common pounds of it at one single time into the crucible; but then you need not observe the proportion of lead prescribed in the foregoing process; nay, a quantity of lead two or three times less is sufficient, according to the different qualities of the object. But the mass will certainly be split, unless you choose a very good crucible; for there is no vessel charged with litharge, that can bear a strong fire having a draught of wind, without giving way through it to the litharge.

“You add glass-gill and common salt, that they may forward the fcorification, by swimming at top; for the refractory scoria rejected by the litharge, and adhering between this and the salts that swim at top, is soon brought to a flux, and the precipitation of the silver is thereby accelerated. They also hinder in a manner a small burning coal fallen into the crucible, from setting the litharge a boiling, which troubles the operation; for the litharge or glass of lead, especially that which is made without any addition, so soon as the phlogiston gets into it, raises into a foamy mass, consisting of a multitude of small bubbles very difficult to be confined, unless the phlogiston be entirely consumed, and the litharge reduced to lead, which sometimes raises above the border of the vessel.”

(A) *Native Copper* is solid; or consisting of friable masses, formed by precipitation of cupreous vitriolic waters, called *cement* or *ziment copper*; or forming crystallized cubes, or grains, leaves, branches, or filaments.

(B) *Calceiform ores* are either pure calxes of copper, or are mixed with heterogeneous matters. 1. The pure are, loose friable ochre, called *ceruleum montanum*, mountain-blue, and *viride montanum*, mountain-green; and the red indurated calx, called improperly *glass copper ore*. 2. *Mixed calceiform ores* are those in which the calx of copper is mixed; with *calcareous earth*, forming a mountain blue; with *iron*, forming a black calx; with *gypsum*, an indurated green ore, called *malachites*; and with *quartz*, a red ore.

(C) *Copper is mineralised*. 1. By *sulphur*, forming the *grey copper ore*, improperly called *vitreous* (minera cupri vitrea Wallerii). 2. By *sulphurated iron*, forming the *hepatic copper ore* (minera cupri hepatica Wallerii) of a brown yellow colour. It is a kind of cupreous pyrites, and is called by Cronstedt *minera cupri pyritacea*. Sometimes it is of a blackish grey colour, and is then called *pyrites cupri griseus* (minera cupri grisea Wallerii); sometimes of a reddish yellow, and tarnished with blue irises on its surface, when it is called *minera cupri lazarea*; when of a yellowish green colour, it is the *pyrites cupri flavo-viridescens* (cuprum sulphure & ferro mineralifatum Wallerii); and when of a pale yellow colour, it is the *pyrites cupri palidus* (sulfurum). Most of the above pyritaceous ores contain also some arsenic, but their sulphur is predominant. 3. *Copper mineralised by sulphur, iron, and arsenic*. *White copper ore* (Minera cupri alba Wall.) This ore contains also some silver. 4. *Copper dissolved by vitriolic acid*. *Native blue vitriol*. 5. *Copper united with bitumens*. *Copper-coal ore*. This is a pit-coal, from the ashes of which copper is obtainable. 6. *Copper is also found in the mineral called kuper nickel*.

*Native metallic silver* may be separated from the stones and earths with which it is intermixed, by *amalgamation with mercury*, which operation is to be performed in the same manner as for the separation of native gold; a detail of which see in Part III. sect. iii.

The *cornuous ore*, if it really be, as Cronstedt says, a luna cornea, ought to be treated in some of the methods directed for the reduction of luna cornea. See CHEMISTRY, n° 366, 367.

#### SECT. IV. Ores of Copper.

§ 1. COPPER is found under ground in three different forms. 1. Native or virgin copper diversely ramified, which is much more rare than native silver. This native copper is not so ductile as copper purified by fusions from the ore (A). 2. Copper is found in form of calx, of verdigrises, of precipitates. Such are the minerals called *filly copper ores*, and several white and green earths. These matters are only copper almost pure and but little mineralised, but which has been corroded, dissolved, precipitated, calcined by saline matters, by the action of the air, of water, and of earths (B). 3. Copper is frequently in a truly mineral state, that is, combined with sulphur, and with arsenic, with other metallic matters mixed with earths, and enveloped in different matrices. These are the true copper ores. They have no regular forms except they partake of the nature of pyrites. Their colours are very different, which depend chiefly on the proportion of the mineral substances composing them. Lastly, in almost all of them we may perceive green or blue colours, which always indicate an erosion or calcination of the copper. Most copper ores contain also some iron or ferruginous earth, to which the ochrey colour is to be attributed, which might make us believe them to be ores of iron. Ores which contain much iron are the most difficultly fusible.

Copper ores have almost all a yellow, golden, and shining colour, by which they are easily distinguished. Some of them are coloured with irises, and frequently have spots of verdigrise, by which also they are distinguishable from other ores.

Many copper ores are also rich in silver. Such is that called the *white copper ore*, the colour of which is rather occasioned by arsenic than by silver, altho' it contains so much silver as to be enumerated by several mine-



Effluxing  
of Ores of  
Copper.

mineralogists amongst silver ores.

Lastly, the pyrites of a golden yellow colour which contains copper and sulphur, and the white pyrites which contains copper and arsenic, are considered as copper ores by several chemists and naturalists. Hencckel and Cramer remark, that no proper ore of copper is known which does not contain a considerable quantity of arsenic.

§. 2. Ores of copper may be effluxed in methods similar to those employed for smelting of large quantities of ores, (Part III.) or they may in general be effluxed by the following processes.

## P R O C E S S I.

To reduce and precipitate copper from a pure and fusible ore in a close vessel.

“ Mix one, or, if you have small weights, two doctimatical centers of ore beat extremely fine, with six centers of the black flux; and having put them into a crucible or pot, cover them one inch high with common salt, and press them down with your finger: but let the capacity of the vessel be such, that it may be only half full; shut the vessel close, put it into the furnace; heap coals upon it, so that it may be covered over with them a few inches high; govern the fire in such a manner, that it may first grow slightly red-hot. Soon after you will hear your common salt crackle; and then there will be a gentle hissing noise. So long as this lasts, keep the same degree of fire till it is quite over. Then increase suddenly the fire, either with the funnel and cover put upon the furnace, or with a pair of bellows applied to the hole of the bottom part, that the vessel may grow very red-hot. Thus you will reduce and precipitate your copper in about a quarter of an hour: then take out the vessel, and strike with a few blows the pavement upon which you put it, that all the small grains of copper may be collected in one mass.

“ Break the vessel, when grown cold, in two, from top to bottom, as nearly as you can: if the whole process has been well performed, you will find a solid, perfectly yellow and malleable regulus adhering to the bottom of the vessel, with scorias remaining at top of a brown colour, solid, hard, and shining, from which the regulus must be separated with several gentle blows of a hammer; this done, weigh it, after having wiped off all the filthiness.

A soft, dusty, and very black, scoria, is a sign of a fire not sufficiently strong. Small neat grains of copper reduced but not precipitated, and adhering still to scorias, especially not very far from the bottom, and an unequal and ramified regulus, are signs of the same thing. A solid, hard, shining, red-coloured scoria, especially about the regulus, or even the regulus itself when covered with a like small crust, are signs of an excess in the degree and duration of the fire.

“ Remarks. All the ores which are easily melted in the fire are not the objects of this process; for they must also be very pure. Such are the vitreous copper ores.” (Mr Cramer means, it is presumed, the red calciform ore called improperly glass ore, and not the *minera cupri vitrea* of Wallerius, which being com-

2

(d) Mr Cramer still means the calciform ores only, and not the mineralised ores of copper.

posed of copper mineralised by sulphur, could not be treated properly by this process, in which no previous roasting is required. The sulphur of this ore would with the alkali of the black flux form a hepar, from which the metal would not precipitate.) “ But especially the green and azure-coloured ores, and the *ceruleum* and *viride montanum*, which are not very different from them. But if there is a great quantity of arsenic, sulphur, or of the ore of another metal and semimetal joined to the ore of copper, then you will never obtain a malleable regulus of pure copper, tho’ ores are not always rendered refractory by the presence of these.”

Effluxing  
of Ores of  
Copper.

## P R O C E S S II.

To reduce and precipitate copper out of ores rendered refractory by earth and stones that cannot be washed off.

“ BEAT your ore into a most subtil powder, of which weigh one or two centers, and mix as much sandiver to them. This done, add four times as much of the black flux with respect to the ore; for by this means, the sterile terrestrial parts are better disposed to a scorification, and the reducing and precipitating flux may act more freely upon the metallic particles freed from all their incumbrances.

“ As for the rest, make the apparatus as in last process: but you must make the fire a little stronger for about half an hour together. When the vessel is grown cold and broken, examine the scorias, whether they are as they ought to be. The regulus will be as fine and ductile as the foregoing.

“ Remarks. As these copper ores hardly conceal any sulphur and arsenic in them, the roasting would be of no effect, and much copper would be lost. For no metallic calx, except those of gold and silver, improperly so called, can be roasted, without you find a part of the metal lost after the reduction.

## P R O C E S S III.

To precipitate copper out of an ore (d) that contains iron.

“ Do all according to last process. But you will find, after the vessel is broken, a regulus upon no account so fine, but less ductile, wherein the genuine colour of the copper does not perfectly appear, and which must be further purified.

“ Remarks. The fire used in this operation is not so strong that the iron should turn to a regulus. But as copper is the menstrum of iron, which is of itself very refractory in the fire; for this reason, while the ore and the flux are most intimately mixed and confounded by trituration, the greatest part of the iron being dissolved by the copper, turns into a regulus along with it.”

## P R O C E S S IV.

The roasting of a pyritose, sulphureous, arsenical, semi-metallic, copper ore.

“ BREAK two doctimatical centers of the ore to a coarse powder, put them into a test covered with a

27 U 2

tile,

tile, and place them under the muffle of a doctormal furnace. But the fire must be fo gentle, that the muffle may be but faintly red-hot. When the ore has decrepitated, open the teft, and continue the fire for a few minutes; then increase it by degrees, that you may fee the ore perpetually fmoking a little: in the mean time, it is alfo proper now and then to ftir it up with an iron hook. The thinng particles will affume a dark red or blackifh colour. This done, take out the teft, that it may grow cold. If the fmall grains are not melted, nor ftrongly adherent to each other, hitherto all will be well; but if they run again into one fingle cake, the procefs muft be made again with another portion of the ore, in a more gentle fire.

“ When the ore is grown cold, beat it to a powder fomewhat finer, and roaft it by the fame method as before; then take it out, and if the powder is not melted yet, beat it again to a moft fubtil powder; in this you are to take care that nothing be loft.

“ Roaft the powder in a fire fomewhat ftronger, but for a few minutes only. If you do not then find the ore any way inclined to melt, add a little tallow, and burn it away under the muffle, and do the fame another time again, till, the fire being very bright, you no longer perceive any fulphureous, arfenical, unpleafant fmell, or any fmoke; and there remains nothing but a thin, foft powder, of a dark red, or blackifh colour.

“ *Remarks.* Every pyrites contains iron, with an unmetallic earth: to which fulphur, or arfenic, and moft commonly both, always join. Befides, there is copper in many pyrites; but fometimes more, and fometimes lefs: fome of them are altogether deftitute of copper; therefore, fo much as pyrites differ with regard to the proportion of their conftituent particles, fo much do they differ as to their difpofition in the fire. For inftance, the more copper there is in pyrites, the more it inclines to colliquation. The more fulphur and arfenic it has in it, the more quickly the melting of it will be procured, and the reverfe: the more iron and unmetallic earth it contains, the more it proves refractory in the fire. Now if fuch pyrites melt in the roafting, as happens to fome of them if they grow but red-hot, the fulphur and arfenic that lies hidden therein are fo ftrofly united with the fixed part, that you would in vain attempt to diffipate them. Nay, in this cafe, when it is reduced again into a powder, it requires a much greater time and accuracy in the regimen of the fire to perform the operation. For this reafon, it is much better to repeat it with new pyrites. But you can roaft no more than the double quantity at once of the ore you have a mind to employ in the foregoing experiment; to the end that the precipitation by fuftion not fucceeding, there may remain ftill another portion entire; left you fhould be obliged to repeat a tedious roafting. If you fee the figns of a ferreous refractory pyrites, the operation muft be performed with a greater fire, and much more quickly. However, take care not to do it with too violent a fire: for a great deal of copper is confumed not only by the arfenic, but alfo by the fulphur; and this happens even in veffels fhut very clofe, when the fulphur is expelled by a fire not quite fo ftrong; which a reiterated and milder fublimation of the fulphur in

a veffel both very clean and well clofed will clearly fhew.

“ When the greateft part of the fulphur and the arfenic is diffipated by fuch caufes as promote colliquation, you may make a ftronger fire: but then it is proper to add a little of fome fat body; for this diffolves mineral fulphur: it changes the mixture of it in fome part, which, for inftance, confifts in a certain proportion of acid and phlogifton; and at the fame time hinders the metallic earth from being reduced into copper, by being burnt to an excels. From thefe effects, the reafon is plain, why aflayers produce lefs metals in the trying of veins of copper, lead, and tin, than ftillful fmelters do in large operations. For the former perform the roafting under a muffle, with a clear fire, and without any oily reducing menftruum; whereas the latter perform it in the middle of charcoal or of wood, which perpetually emit a reductive phlogifton.

“ The darker and blacker the powder of the roafted ore appears, the more copper you may expect from it. But the redder it looks, the lefs copper and the more iron it affords; for roafted copper difolved by fulphur or the acid of it is very black, and iron, on the contrary, very red.

#### P R O C E S S V.

*The precipitation of copper out of roafted ore of the laft procefs.*

“ Divide the roafted ore into two parts: each of them fhall go for a centner: add to it the fame weight of fandiver, and four times as much of the black flux, and mix them well together. As for the reft, do all according to the procefs I: the precipitated regulus will be half malleable, fometimes quite brittle, now and then pretty much like pure copper in its colour, but fometimes whitifh, and even blackifh. Whence it is moft commonly called *black copper*, tho’ it is not always of fo dark a dye.

“ It is eafy to conceive, that there is as great a difference between the feveral kinds of that metal called *black copper*, as there is between the pyritofe and other copper ores accidentally mixed with other metallic and femi-metallic bodies. For all the metals, the ores of which are intermixed with the copper ores, being reduced, are precipitated together with the copper, which is brought about by means of the black flux. Wherefore iron, lead, tin, the reguline part of antimony, biftmuth, moft commonly are mixed with black copper in a multitude of different proportions. Nay, it is felf-evident, that gold and filver, which are difolvable by all thefe matters, are collected in fuch a regulus when they have been firft hidden in the ore. Befides, fulphur and arfenic are not always altogether abfent. For they can hardly be expelled perfectly by the many preceding roaftings, but there remain fome veftiges of them, which are not diffipated by a fudden melting, efpecially in a clofe veffel, wherein the flux fwimming at top hinders the action of the air. Nay, arfenic is rather fixed by the black flux, and affumes a reguline femi-metallic form, while it is at the fame time preferved from diffipating by the copper.

## P R O C E S S VI.

To reduce black copper into pure copper by scorification.

“SEPARATE a specimen of your black copper, of the weight of two small dochemical centners at least; and do it in the same manner, and with the same precautions, as if you would detect a quantity of silver in black copper.

“Then with lute and coal-dust, make a bed in the cavity of a test moistened: when this bed is dry, put it under the muffle of the dochemical furnace, in the open orifice of which there must be bright burning coals, wherewith the test must likewise be surrounded on all parts. When the whole is perfectly red-hot, put your copper into the fire, alone, if it contains lead; but if it is altogether destitute of it, add a small quantity of glass of lead, and with a pair of hand-bellows increase the fire, that the whole may melt with all speed: this done, let the fire be made a little violent, and such as will suffice to keep the metallic mass well melted; and not much greater. The melted mass will boil, and scoriae will be produced, that will gather at the circumference. All the heterogeneous matters being at last partly dissipated, and partly turned to scoriae, the surface of the pure melted copper will appear. So soon as you see it, take the pot out of the fire, and extinguish it in water: then examine it in a balance, and if lead has been at first mixed with your black-copper, add to the regulus remaining of the pure copper, one 15th part of its weight which the copper has lost by means of the lead, then break it with a vice; and thus you will be able to judge by its colour and malleability, and by the surface of it after it is broken, whether the purifying of it has been well performed or no. But whatever caution you may use in the performing of this process, the product will nevertheless be always less in proportion than what you can get by a greater operation, provided the copper be well purified in the small trial.

“Remarks. This is the last purifying of copper, whereby the separation of the heterogeneous bodies begun in the foregoing process is completed as perfectly as it possibly can be. For, except gold and silver, all the other metals and semimetals are partly dissipated and partly burnt, together with the sulphur and arsenic. For in the fusion they either turn of themselves to scoria or fumes, or this is performed by means of iron, which chiefly absorbs semimetals, sulphur and arsenic, and the destruction of it is at the same time accelerated by them. Thus the copper is precipitated out of them pure; for it is self-evident, that the unmetallic earth is expelled, the copper being reduced from a vitrescent terrestrial to a metallic state, and the arsenic being dissipated by means of which the said earth has been joined to the coarser regulus of the first fusion. But there is at the same time a good quantity of the copper that gets into the scoriae: however, a great part of it may be reduced out of them by repeating the fusion.

“The fire in this process must be applied with all imaginable speed, to make it soon run: for if you neglect this, much of your copper is burnt; because copper that is only red-hot, cleaves much sooner, and

in much greater quantity, into half-scorified scales, than it is diminished in the same time when melted. However, too impetuous a fire, and one much greater than is necessary for the fusion of it, destroys a much greater quantity of it than a fire sufficient only to put it in fusion would do. For this reason, when the purifying is finished, the body melted must be extinguished in water together with the vessel, left, being already grown hard, it should still remain hot for a while; which must be done very carefully to prevent dangerous explosions.

“The scoria of the above process frequently contains copper. To extract which, let two or three dochemical centners of the scoria, if it be charged with sulphur, be beat to a subtil powder, and mix it, either alone, or, if its refractory nature requires it, with some very fusible common pounded glass without a reducing saline flux, and melt it in a clove vessel, and in a fire having a draught of air; by which you will obtain a regulus.

“But when the scoria has little or no sulphur at all in it, take one centner of it, and with the black flux make it as you do the fusible copper ore, (process I.) by which you will have a pure regulus.”

## P R O C E S S VII.

The following process is translated from Mr Gellert's *Elements of Essaying*, and describes a new method of essaying ores, concerning which, see the section *Of Essaying in general*, p. 4922, col. 2.

To assay copper ores.

ROAST a quintal of ore [in the manner described in process IV.]; add to it an equal quantity of borax, half a quintal of fusible glass, and a quarter of a quintal of pitch: put the mixture in a crucible, the inner surface of which has been previously rubbed with a fluid paste of charcoal-dust and water: cover the whole with pounded glass mixed with a little borax, or with decrepitated sea-salt: put a lid on the crucible, which you will place in an air-furnace, or in a blast-furnace: when the fire shall have extended to the bottom of the coals, let it be excited briskly during half an hour, that the crucible may be of a brick red colour: then withdraw the crucible, and when it is cold break it: observe if the scoria be well made: separate the regulus, which ought to be semi-ductile; and weigh it. This regulus is black copper; which must be purified, as in process VI.

If the ore be very poor, and enveloped in much earthy and stony matters; to a quintal of it, a quintal and a half of borax, a quarter of a quintal of pitch, and ten pounds of calx of lead or minium, must be added. The calx of lead will be revived, and will unite with the scattered particles of the copper, and together with these will fall to the bottom of the crucible, forming a compound regulus. When the ores of copper are very rich, half a quintal of borax and a quarter of a quintal of glass will be sufficient for the reduction. If the ore is charged with much antimony, a half or three quarters of a quintal of clean iron-slugs may be added; otherwise the large quantity of antimony might destroy the copper, especially if the ore contained no lead. If iron be contained in copper ore, as in pyrites, some pounds of antimony, or of its regulus, may be

be added in the essay; as these substances more readily unite with iron than with copper, and therefore disengage the latter metal from the former.

together with tartar and common salt, or with alum and common salt: but we have not found this method so effectual as the preceding.

Effaying  
of Ores of  
Copper.

## P R O C E S S V I I.

To essay Ores of Copper by humid Solution.

SOME pyrites and ores contain so small a quantity of copper, that it cannot be separated by the above processes, but is destroyed by the repeated roastings and fusions. These, and indeed any copper-ores, may be essayed by humid solution, or by menstrua.

1. By roasting a sulphureous ore, the sulphur is burnt or decomposed, its phlogiston with part of the acid evaporating, while the remaining part of the acid combines with the metals, especially with the copper and iron contained in the ore. Accordingly, from an ore thus roasted, a vitriolic solution may be obtained by lixiviation with warm water, especially if the ore has been exposed, during a few days after it has been roasted, to a moist air; as the water thus gradually applied unites better with the combination of the metallic calxes with the concentrated vitriolic acid of the sulphur: but all the copper is not thus reduced by one operation to a vitriol. More sulphur must therefore be combined with the residuous ore by fusion, and must be again burnt off, that the remaining part of the copper may be attacked by some of the acid of the sulphur. By repeating this operation, almost all the copper and iron will be reduced to a vitriolic lixivium, from which the copper may be separated and precipitated by adding clean pieces of iron.

2. Copper-ores may be more easily essayed by humid solution in the following manner:

Roast the mineralized ores in the manner directed in Process IV. and pulverise them. If the ores be calciform, they do not require a previous roasting. Put this powder into a matras capable of containing ten times the quantity of the ore; pour upon the ore some water: set the matras in a sand-bath, that the water may boil: pour off the lixivium: add to the residuous ore more water, with some vitriolic or marine acid: digest as before in the sand-bath, and add this lixivium to the former: repeat this operation, till you find that the acid liquor dissolves no more metal.

By adding clean plates of iron you may precipitate the copper, which ought then to be collected, fused with a little borax and charcoal dust, and weighed.

We may remark, that although copper is not soluble by a dilute vitriolic acid, yet the calx of it obtained by roasting the ore, and also the calciform ores, are readily soluble in that acid.

3. Stahl advises to essay copper-ores by boiling them, after they have been roasted and powdered, in water,

## P R O C E S S V I I I.

Dr Fordyce's method of essaying copper ores, by means of Aqua Regia. [Phil. Trans. for 1781, vol. lxxx. art. 3.]

THIS method consists only in pouring a quantity of an aqua regia composed of equal parts of the nitrous and muriatic acids upon a small quantity of the ore in powder, till a fresh affusion of the menstruum shews no green or blue tinge; by which means all the metalline part of the ore will be dissolved. It is then to be precipitated by means of a solution of fixed alkali, or volatile alkali cautiously managed will answer the same purpose. The metal then appears in form of a green precipitate called *green verditer*; or is mixed with what calcareous earth might have been contained in the ore; which the acids would dissolve, and the fixed alkali, if that kind was used, would precipitate. The caustic volatile alkali would not throw down this earth, and is therefore to be preferred to any other; but care must be taken to hit the point of saturation very exactly with it, as it violently dissolves the metal if added in too great quantity. Dr Fordyce orders this green calx to be dissolved in vitriolic acid, and then, by adding a piece of clean iron to the solution, all the copper contained in the ore will be obtained in its metallic form.

This method can be subject to no fallacy, unless the ore contains aluminous matter, in which case some of the earth of alum will be mixed with the metal, as that earth will be precipitated by fixed alkali, by caustic volatile alkali, and by iron. This, however, may very effectually be prevented by dissolving the green calx first in volatile alkali, and then in vitriolic acid. It is even probable, that by reducing the ore to a very fine powder, and treating it with caustic alkali, all the metal might be separated from the ore, without the trouble of using aqua regia. For the principles on which this method is conducted, see the article CHEMISTRY *passim*.

## S E C T. V. Ores of Lead.

LEAD is seldom found native (E) and malleable. Neither, says Mr Macquer (F), is it found in form of calx or precipitate, as copper is, because it is much less liable to lose its phlogiston by the action of air and water: therefore almost all lead is found naturally mineralized.

Lead is generally mineralized by sulphur (G). Its ores have a dark white, but a shining metallic colour.

These

(E) Cronstedt doubts whether any native lead has been found. Linnæus says, he has seen what externally appeared to be such.

(F) But he is mistaken. As lead unites strongly with vitriolic acid, we might expect to meet ochres of this metal as well as of copper. Accordingly, we find some calciform ores of lead. 1. A pure calx of lead, in form of a friable ochre, *cerussa nativa*, found on the surface of galena; or it is indurated with a radiated or fibrous texture, of a white or yellowish green colour, and resembling spar; it is called *spatum plumbi*, *sparry lead-ore*, and *lead-spar*. 2. A calx of lead is found mixed with calx of arsenic, forming the ore called *arsenicated lead-spar*. Sometimes also that calx is mixed with calcareous earth.

(G) Lead is mineralized, 1. With sulphur; such are the several kinds of steel-grained and tessellated galenas, which also contain generally some silver. 2. With sulphurated iron and silver. It is fine-grained or tessellated, and is diffin-

*Ores of Lead* These ores, although they form irregular masses, are internally regularly disposed, and seem to be composed of cubes of different sizes applied to each other, but not adherent. These ores are generally distinguished by the name of *Galena*. They commonly contain about three quarters of lead and a quarter of sulphur. They are accordingly heavy and fusible, although much less so than pure lead.

Most lead-ores contain silver; none but those of Wirlach in Carinthia are known to be quite free from it: some of them contain so much of it, that they are considered as improper ores of silver. The smaller the cubes of galena are, the larger quantity of silver has been remarked to be generally contained.

§ 2. *Lead ores may be essayed*, 1. By means of the black flux, in the manner directed by Mr Cramer, as follows:

“ Let one or more quintals of this ore be grossly powdered, and roasted in a telt till no more sulphureous vapours be exhaled, and then reduced to a finer powder; it is then to be accurately mixed with twice its weight of black flux, a fourth part of its weight of clean filings of iron and of borax. The mixture is to be put into a good crucible, or rather into a telt; it is then to be covered with a thickness of two or three fingers of decrepitated sea-salt; the crucible is to be closed, and placed in a melting furnace, which is to be filled with unlighted charcoal, so that the top of the crucible shall be covered with it. Lighted coals are then to be thrown upon the unkindled charcoal, and the whole is left to kindle slowly, till the crucible be red-hot; soon after which a hissing noise proceeds from the crucible, which is occasioned by the reduction of the lead: the same degree of fire is to be maintained while this noise continues, and is afterwards to be suddenly increased, so as to make a perfect fusion; in which state it is to be continued during a quarter of an hour; after which it is to be extinguished; and the operation is then finished.”—The filings of iron are added to the mixture, to absorb the sulphur, a certain quantity of which generally remains united with the lead-ore, notwithstanding the roasting. We need not fear lest this metal should unite with the lead and alter its purity; because, although the sulphur should not hinder it, these two metals cannot be united. The refractory quality of the iron does not impede the fusion; for the union it forms with the sulphur renders it so fusible, that it becomes itself a kind of flux.—This addition of iron in the essay of lead-ores would be useless, if the ores were sufficiently roasted, so that no sulphur should remain.

Or, 2. By the following process of Mr Gellert.

“ Mix a quintal of roasted-lead ore with a quintal of calcined borax, half a quintal of glass finely pulverised, a quarter of a quintal of pitch, and as much of clean iron-filings: put this mixture into a crucible wetted with charcoal-dust and water: place the crucible before the nozzle of the bellows of a forge, and when it is red raise the fire during 15 or 20 minutes; then withdraw the crucible, and break it when cold.”

Some very fusible ores, such as the galena of Derbyshire, may be essayed, as large quantities of it are

smelted, without previous roasting, and without addition, merely by fusion during a certain time. For this purpose nothing more is requisite than to keep the ore melted in a crucible with a moderate heat, till all the sulphur is destroyed, and the metal be collected. To prevent the destruction of any part of the metal after it is separated from the sulphur, some charcoal dust may be thrown over the ore, when put into the crucible; but if the galena be mixed with pyrites, especially arsenical pyrites, it requires much roasting and saline fluxes.

#### SECT. VI. *Tin Ores.*

§ 1. *Tin* is very seldom found pure, but almost always mineralized, and chiefly by arsenic.

The richest ore of tin is of an irregular form, of a black or tarnished colour, and almost the heaviness of all ores. The cause of this extraordinary weight is, that it contains much more arsenic than sulphur, whereas most ores contain more sulphur than arsenic.

The most common tin ore is of the colour of rust, which proceeds from a quantity of iron, or of iron-ore mixed with it. The tin-ores of Saxony and Bohemia appear to be all of this kind.

One kind of tin-ore is semi-transparent and like spar. Lastly, several kinds of garnets are enumerated by mineralogists among tin-ores, because they actually contain tin.

The county of Cornwall, in England, is very rich in tin-ores; and the tin contained in them is very pure. From tin-mines in the East Indies tin is brought, called *Malacca tin*. No mines of tin have been discovered in France; only in Bretagne garnets are found which contain some tin.

Native tin is said to have been found in Saxony and Malacca. Its ores are all of the calciform kind, excepting black-lead, which appears to be tin mineralized by sulphur and iron.

The calciform ores of tin are, 1. Tin-stone, which is of a blackish-brown colour, and of no determinate figure; and tin-grains, or crystals of tin, which resemble garnets, and are of a spherical or polygonal figure, which they have probably acquired by the attrition of their angles. The tin-stone seems to consist of attrited tin-grains. This ore is calc of tin united with calc of arsenic, and frequently with calc of iron. 2. Garnets are said to contain calc of tin united with calc of iron. 3. Manganese is said also to contain tin.

§ 2. *Ores of tin may be essayed* in the same manner, according to Cramer, as he directed for the essay of lead-ores, *supra*. He further makes upon this essay the following remarks.

1. Tin-ore, on account of its greater gravity, admits better of being separated, by elutriation or washing, from earths, stones, and lighter ores. 2. A most exact separation of earths and stones ought to be made, because the scorification of these by fluxes requires such a heat as would destroy the reduced tin. 3. The iron ought to be separated by a magnet. 4. By a previous roasting, the arsenic is dissipated, which would otherwise carry off a great deal of tin along with it in a melting

distinguished from the former by yielding a black slag when scorified, whereas the former yields a yellow slag. 3. With sulphurated antimony and silver. *Plumbum fibiatum Linnæi*. Its colour is similar to that of galena, and its texture is friated. 4. With sulphur and arsenic. This cure is soft, almost malleable, like lead. From this ore lead may be melted by the flame of a candle.

Ores of Iron

ing heat, would change another part of it into ashes, and would vitiate the remaining tin. 5. The effay of tin is very precarious and uncertain; because tin once reduced is easily destructible by the fire, and by the saline fluxes requisite for the reduction.

Mr Gellert directs, that ores of tin should be essayed in the following manner:

“ Mix a quintal of tin-ore, washed, pulverized, and twice roasted, with half a quintal of calcined borax, and half a quintal of pulverized pitch: these are to be put into a crucible moistened with charcoal-dust and water, and the crucible placed in an air-furnace: after the pitch is burnt, give a violent fire during a quarter of an hour; and then withdraw your crucible. If the ore be not very well washed from the earthy matters, as it ought to be, a larger quantity of borax is requisite, with some powdered glass, by which the too quick fusion of the borax is retarded, and the precipitation of the earthy matters is prevented. If the ore contains iron, to the above mixture may be added some alkaline salt.

#### SECT. VII. *Ores of Iron.*

§. 1. IRON is seldom found in its metallic state, and free from admixture; though Cramer gives an account of an ore which needs only to be put into a forge, and heated to a welding heat. Several sands and earths also have the appearance of iron, and are even attractable by a magnet. The ore mentioned by Cramer is found vitrified; with moderate blows the scorias are thrown out, and a mass of iron obtained, which, by being put into the forge again, gives tough iron without any other process. But in general this metal is found in the state of a calx; or, though it is combined with a great quantity of the principle of inflammability, it has seldom enough of the metallic form; and it is very often intermixed with a certain proportion of sulphur. The minerals wrought for iron are three, viz. iron-ore, iron-stone, and bog-ore.

The iron ore is found in veins as the ores of other metals are, and the appearance is very various; sometimes it has a rusty iron colour resembling that of iron; sometimes it has a reddish cast; often it is formed into a sort of crystallizations which are protuberant knobs on the outside; and these consist of fibres tending to a common centre; and it is of a dark colour like coagulated blood. It is called *hematites*, or *blood-stone*; and consists of a calx of iron with a small quantity of vitriolic acid.

Iron-stone in this country is clay found in strata with coal; but which contains a large quantity of iron, so as to make the working profitable. Sometimes it has little appearance of iron; but, when burnt with a certain degree of heat, it becomes of a deep red.

The bog-ore is an ochre of iron, and is found generally in low situations, and in springs containing a small quantity of iron, which flowing over these grounds deposits it in the form of ochre; and after a number of ages it proves a rich mine of iron, and it is extracted from a calx of this kind in many parts of the world. There is also a particular kind of spar found in different countries of a pale blue colour, so that from its first appearance we would expect copper; but it contains a small quantity of iron, and is a combina-

tion of the metal with inflammable matter, as in Prussian blue.

The loadstone is a noted iron ore. It is always found in veins, and it is alleged that it is only possessed of its magnetic qualities when near the surface. In appearance, it does not differ from many of the ores of iron, and treated as an ore, it affords a considerable quantity of metal.

Neither is iron generally mineralized so distinctly as other metals are, unless in pyrites and ores of other metals.

Most of the minerals called *iron ores* have an earthy, rusty, yellowish, or brownish appearance, which proceeds from the facility with which the true iron ores are decomposed.

Iron is the most common and most abundant of all metals. In Europe, at least, we cannot find an earth, a sand, a chalk, a clay, a vitrifiable or calcinable stone, or even the ashes of any substance, which do not contain an earth convertible into iron. All earths and stones which are naturally yellow or red, and all those which acquire these colours by calcination, receive them from the ferruginous earth mixed with them. The yellow and red ochres consist almost solely of this earth: the black and heavy sands are generally very ferruginous.

The iron ore most commonly found is a stone of the colour of rust, of an intermediate weight betwixt those of ores in general and of unmetallic stones. This ore has no determinate form, and easily furnishes an iron of good quality.

Blood-stone or hematites, sanguine or red chalk, and emery, are iron ores; some of which, for instance blood-stone, are almost all iron. Most of these substances require but a slight calcination to be rendered very attractable by a magnet, and soluble in aqua fortis; but the iron obtained from them is of a bad quality, and they are therefore neglected. Iron from the hematites is very brittle; that obtained from ochrea is red-short. All these iron ores are so refractory, that they can scarcely be fused.

Iron ores are very various in their form; or rather they have no determinate form. Sometimes they are earths, sometimes stones, sometimes grains. Accordingly, those naturalists who attend only to the external form of things in classing and subdividing minerals, have been obliged to multiply the names of iron ores: hence they are called *iron ores in form of pease, of beans, of coriander seeds, of pepper-corns, of cinnamon*, &c. which Mr Cramer treats as ridiculous trifles,

§. 2. *Ores of iron may be essayed by the following process.*

#### P R O C E S S I.

[Cramer's *Art of Assaying*, Proc. 54.]

To reduce a precipitate iron out of its ore in a close vessel.

“ ROAST for a few minutes in a test under a muffle, and with a pretty strong fire, two centers of the small weight of your iron ore grossly pulverized; that the volatiles may be diffipated in part, and the ore itself be softened in case it should be too hard. When it

Effaying  
Of Ores of  
Iron.

is grown cold, beat it extremely fine, and roast it a second time, as you do the copper-ore, but in a much stronger fire, till it no longer emits any smell; then let it grow cold again. Compose a flux of three parts of the white flux, with one part of fusible pulverised glass, or of the like sterile unfulphureous scorias, and add sandifer and coal-dust, of each one half-part; add of this flux three times the quantity of your roasted ore, and mix the whole very well together; then choose a very good crucible, well rubbed with lute within, to stop the pores that may be here and there unseen; put into it the ore mixed with the flux; cover it over with common salt; and shut it close with a tile, and with lute applied to the points.

“Put the wind-furnace upon its bottom-part, having a bed made of coal-dust. Introduce besides into the furnace a small grate supported on its iron bars, and a stone upon it, whereon the crucible may stand as on a support: surround the whole with hard coals, not very large, and light them at top. When the vessel begins to grow red, which is indicated by the common salt's ceasing to crackle, stop with gross lute the holes of the bottom-part, except that in which the nozzle of the bellows is received: blow the fire, and excite it with great force, adding now and then fresh fuel, that the vessel may never be naked at top: having thus continued your fire in its full strength for three quarters of an hour, or for a whole hour, take next the vessel out of it, and strike several times the pavement upon which it is set, that the small grains of iron which happen to be dispersed may be collected into a regulus, which you will find after having broken the vessel.

“When the regulus is weighed, try its malleability: then make it red-hot; and when so, strike it with a hammer: if it bears the strokes of a hammer, both when red-hot and when cold, and extends a little, you may pronounce your iron very good; but if, when either hot or cold, it proves brittle, you may judge it to be not quite pure, but still in a semi-mineral condition.

“Remarks. The arsenic, but especially the sulphur, must be dissipated by roasting: for the former renders the iron brittle; and the latter not only does the same, but, being managed in a close vessel, with a saline alkaline flux, turns to liver of sulphur; to the action of which iron yielding in every respect, it can upon no account be precipitated; and if not the whole, a great part of it, at least, is retained by the sulphureous scoria; so that in this case you commonly in vain look for a regulus.

“The iron obtained from this first precipitation has hardly ever the requisite ductility, but is rather brittle: the reason of which is, that the sulphur and arsenic remain in it; for notwithstanding that the greatest part of these is dissipated by roasting, yet some part adheres so strictly, that it can never be separated but with absorbent, terrestrial, alkaline ingredients, that change the nature of the sulphur. For which reason, in larger operations, they add quicklime, or marble stones that turn into quicklime; which, while they absorb the said minerals, are, by it, and by help of the destroyed part of the iron, brought to a fusion, and turn to a vitrified scoria; although, at other times, they refit so much by their own nature a

vitriification. Another cause of the brittleness of iron is the unmetallic earth, when it is not yet separated from it; for the iron ore contains a great quantity of it, and in the melting remains joined with the reguline part: whence the iron is rendered very coarse and brittle. Some iron ores are altogether untractable: nevertheless, the regulines produced out of them, when broken, have sometimes a neat semi-metallic look; which proceeds undoubtedly from a mixture of a small quantity of some other metal or semi-metal.”

## PROCESS II.

[The following Process for effaying iron ores, and ferruginous stones and earths, is extracted from Mr Gellert's *Elements of Effaying*.]

“ROAST two quintals of iron ore, or of ferruginous earth: divide the roasted matter into two equal parts; to each of which add half a quintal of pulverised glass, if the substance be fusible and contain much metal; but if otherwise, add also half a quintal of calcined borax. If the roasting has entirely disengaged the sulphur and arsenic, an eighth part, or even half a quintal, of quicklime may be added. With the above matters, mix twelve pounds of charcoal-powder.

“Take a crucible, and cover the bottom and sides of its inner surface with a paste made of three parts of charcoal-dust and one part of clay beat together. In the hollow left in this paste put the above mixture; press it lightly down; cover it with pulverised glass; and put on the lid of the crucible.

“Place two such crucibles at the distance of about four fingers from the air-pipe, in such a manner that the air shall pass betwixt them at about the third part of the height from the bottom: fill the space betwixt the two crucibles with coals of a moderate size: throw lighted coals upon them, that the fire may descend and make them red-hot from top to bottom: at first let the bellows blow softly, and afterwards strongly during an hour, or an hour and a quarter: then take away the crucible, and break it when cold. A regulus will be found in the bottom, and sometimes some small grains of iron in the scoria, which must be separated and weighed along with the regulus: then try the regulus, whether it can be extended under the hammer, when hot and when cold.

“Remarks. To disengage a metal from the earthy matters mixed with it by fire, we must change these matters into scoria or glass. This change may be effected by adding some substance capable of dissolving these matters; that is, of converting them into a scoria or glass, from which the metallic matters may, by their weight, separate and form a regulus at bottom. Fixed alkali, which is an ingredient of the black and of the white flux, is a powerful solvent of earths and stones: but the alkali does also dissolve iron, especially when this is in a calcined or earthy state; and this solution is so much more complete, as the fire is longer applied. Hence, in ordinary essays, where an alkaline salt is used, little or no regulus of iron is obtained. Now, glass acts upon and dissolves earths and stones; but not, or very little, iron: consequently glass is the best flux for such essays, and experience confirms this assertion. If the ore contains but little iron, we may also

also add to the glass some borax; but borax cannot be employed singly, because it very soon fuses, and separates from the ore before the metal is revived. Quicklime is added, not only to absorb the sulphur and arsenic remaining in the ore, but also because it dissolves and vitrifies the stony and earthy matters of iron ores, which are generally argillaceous. For which reason, in the large operations for smelting iron ore, quicklime, and even in certain cases gypsum, are commonly added to facilitate the fusion.

The reduction of iron-ore, and even the fusion of iron, requires a violent and long-continued heat: therefore, in this operation, we must not employ an inflammable substance, as pitch, that is soon consumed, but charcoal pulverised, which in close vessels is not sensibly wasted. Too much charcoal must not be added, else it will prevent the action of the glass upon the earthy matter of the ore, and consequently the separation of the metallic part. Experiments have taught me, that one part of charcoal-dust to eight parts of ore was the best proportion.

When iron is surrounded by charcoal, it is not decomposed or destroyed: hence the iron of the ore, which sinks into the hollow made of paste of charcoal-dust and clay, remains there unhurt. The clay is added in this paste to render it more compact, and to keep the fluid iron collected together.

The air is directed betwixt the crucibles; because if it was thrown directly upon them, they would scarcely be able to resist the heat. The space betwixt the air-pipe and the crucibles ought to be constantly filled with charcoal, to prevent the cold air from touching the crucibles. Ductile and malleable iron is seldom obtained in this first operation. The sulphur and arsenic, and frequently also an earthy matter adhering to the iron, prevent these qualities.

### SECT. VIII. Ores of Mercury.

§ 1. MERCURY is sometimes found pure, fluid, and in its proper metallic state, only mixed with earths and stones. Such are the ores of mercury found near Montpellier, in Tuscany, and in other places.

But the largest quantity of the mercury found in the earth is mineralised by sulphur, and consequently is in the form of cinnabar.

Mercury is never mineralised by arsenic. The richest mine of mercury is that of Almaden, in Spain.

Linnæus and Cronstedt mention a singular ore, in which the mercury is mineralised by sulphur and by copper. It is said to be of a blackish-grey colour, of a glassy texture, and brittle. When the mercury and sulphur are expelled by fire, the copper is discovered by giving an opaque red colour to glass of borax, which, by continuance and increase of heat, becomes green and transparent.

§ 2. Cramer directs, that ores of mercury should be essayed by the following Processes.

#### P R O C E S S I .

To separate Mercury out of an unfulphureous Ore by Distillation.

“ TAKE a lump of the pulverised ore, one common pound, which must stand for one centner: put it into

a glass retort perfectly clean, well loricated, or coated up to half the length of its neck: this must be very long, and turned backwards with such a declivity, that a glass recipient may be perpendicularly applied to it; but you must choose a retort small enough, that the belly of it may be filled hardly two-thirds with the ore: this retort must be placed so, that nothing of the fluid adherent to the neck of it may fall into the cavity of the belly, but that the whole may run forward into the recipient. Finally, have a small recipient full of cold water: let it be perpendicularly situated, and receive the neck of the retort in such manner that the extremity of it be hardly one half-inch immersed into the water.

“ Let the retort be surrounded with hot burning coals placed at some distance in form of a circle, lest the vessel should burst by too sudden a heat: then by degrees bring the burning coals nearer and nearer, and at last surround the whole retort with them and with fresh charcoal, that it may grow slightly red-hot: this fire having been continued for an hour, let the retort cool of itself: then strike the neck of it gently, that the large drops which are always adherent to it may fall into the recipient: let the recipient be taken away, and the water separated from the mercury by filtration, and let the mercury be weighed. This operation may be more conveniently performed in a sand-bath; in which case the pot containing the sand must be middling red-hot, and the retort be able to touch the bottom of it immediately; nor is it then necessary that the retort be loricated.”

#### P R O C E S S II .

To revive Mercury from a sulphureous Cinnabar-ore.

“ BEAT your ore extremely fine, and mix it exactly with an equal portion of iron-slings, not rusty; proceed to distill it with the same apparatus as in the former process, but urge it with the strongest fire that can be made.

“ Cinnabar may be separated from stones by sublimation thus: Beat it to a fine powder, and put it into a small narrow glass or earthen cucurbit, the belly of which it must not fill more than one-third part: stop the orifice at top; this must be very narrow, to hinder the free action of the air. Put this small cucurbit in an earthen pot above two inches wide in diameter, and gather sand around this pot about as high as the pulverised ore rises in the cucurbit. Then put it upon burning coals in such manner that the bottom of the pot may be middling red-hot. Thus will your cinnabar ascend and form a solid ponderous ring, which must be got out by breaking the vessel.”

### SECT. IX. Ore of the Regulus of Antimony.

NATIVE regulus of antimony was first observed by Mr Swab, in Sweden, in the mine of Salberg, and described by him in the memoirs of the Swedish Academy in 1749. Mr Wallerius mentions it in his Mineralogy.

Regulus of antimony is generally united with sulphur, with which it forms antimony, which ought to be considered as a true ore of the regulus of antimony.

Another ore of regulus of antimony is also known, of



Ores of Antimony.

of a red colour, in which the regulus is mineralised both by arsenic and by sulphur. This ore resembles some iron ores, and some kinds of blend. It is distinguished by its great fusibility, which is such, that it may be easily melted by the flame of a candle.

The *native regulus* of antimony, by Von Sweb, is said by that author to have differed from the regulus of antimony obtained from ores, in these two properties, that it was capable of being easily amalgamated with mercury, and that its calx shot into crystals during the cooling.

Besides the ores of regulus of antimony enumerated above, this femetals is also found in ores of other metallic substances, as in the *plumose silver-ore*, and in the *fibriated lead-ore*.

§ 2. The ores of antimony may be assayed by the following processes described by Mr Cramer.

## P R O C E S S I.

To obtain antimony from its ore.

“Choose a melting crucible, or an earthen pot not glazed, that may contain some common pounds of the ore of antimony, broken into small bits. Bore at the bottom of the crucible some small holes, two lines in diameter. Let the bottom of the vessel be received by the orifice of a smaller one, upon which it must be put; and when the ore is put into it, let it be covered with a tile, and all the joints be stopped with lute.

“Put these vessels upon the pavement of a hearth, and put stones all around them at the distance of six inches. Fill this intermediate space with ashes, so high that the inferior pot be covered to the upper brim. Then put fresh and burning coals upon it, and with a pair of hand-bellows excite the fire, till the upper vessels grow red-hot: take off the fire a quarter of an hour after; and when the vessels are grown cold, open them. You will find that the melted antimony has run through the holes made at the bottom of the upper vessel into the inferior one, where it is collected.”

## P R O C E S S II.

To roast crude antimony, or its ore, with or without addition.

“Choose an earthen, flat, low dish, not glazed; and if it cannot bear being made middling red-hot, cover it over with a coat of lute without. Spread it thinly over with crude antimony, or with its ore, beaten to a pretty coarse powder, not exceeding a few ounces at once. Put the dish upon a fire-pan, having a few burning coals in it: increase the fire till it begins to smoke a little. Meanwhile you must incessantly move the powder with a piece of new tobacco-pipe; for this causes the sulphur to evaporate the sooner. If you increase the fire a little too soon, the powder immediately gathers into large clots, or even begins to melt. When this happens, take it immediately off the fire before it melts entirely. Then pulverise it again, and finally make a gentle fire under it. Your black shining powder will assume an ash-colour almost like that of earth, and become more refractory in the fire; wherefore you may then increase the fire till your

powder grows middling red-hot, and let it last till it ceases to smoke. If you add to your crude antimony pulverised, half or an equal quantity of charcoal-duit, and perform the rest as above, the roasting will be done more conveniently: for it does not gather so easily into clots, and melts with much greater difficulty. When part of the sulphur is evaporated, add some fat to it at several times. Thus you will sooner finish the operation, and the remaining calx will not be burnt to excess. However, if it be thus exposed to too violent and long-lasting a fire, a great quantity of it evaporates; nor does it cease entirely to smoke in a great fire. And it will be enough, if, growing middling red-hot, it does no longer emit the unpleasant smell of the acid of sulphur.”

## P R O C E S S III.

To reduce a calx of antimony into a semi-metallic regulus.

“Mix some calx of antimony with a quarter part of the black flux, and put it into the crucible. Cover the vessel with a tile; make the fire as quickly as the vessel can bear it, but not greater than is necessary to melt the flux. When the whole has been well in fusion for half a quarter of an hour (which may be tried with a tobacco-pipe, taking off the tile) pour it into the melting cone, which must be warm and done over with tallow. Then immediately strike the cone several times. You will find, when the cone is inverted, a regulus, above which is a saline scoria.”

The methods of calcining antimony by means of nitre, are described under CHEMISTRY, n° 489—459; and those of obtaining a regulus of antimony without a previous calcination or roasting, by throwing a mixture of powdered antimony, tartar, and nitre, into a red-hot crucible, and by fusing this mixture, and of obtaining a martial regulus of antimony, are described at the article REGULUS.

## S E C T. X. Ores of Bismuth.

§ 1. BISMUTH is found native, resembling the regulus of bismuth.

An *ochre* of bismuth, of a whitish yellow colour, is mentioned by Cronstedt; and is different from the ore improperly called *flowers of bismuth*, which is a calx of calx.

Bismuth is mineralised, 1. By sulphur. This ore has the appearance of galena. 2. With sulphurated iron. Bismuth is found also in cobalts, and in some ores of silver.

§ 2. Ores of Bismuth may be assayed by the following process.

## P R O C E S S I.

To melt bismuth from its ore.

“BISMUTH ore may be melted with the same apparatus as was directed for the fusion of crude antimony out of its ore. Or you may beat your ore to a very fine powder, with the black flux, sandiver, and common salt, in a close vessel, like the ore of lead, or of tin, and melt it in a middling fire, having a draught of air. But as this semi-metal is destructible and volatile, you must as quick as possible apply to it that degree of fire which the flux requires to be melted; and

and so soon as it is well melted, the vessel must be taken out of the fire; and when it is grown quite cold and broken, you will find your regulus."

Mr Gellert directs that ores of bismuth should be effayed by fusing a quintal of pulverised ore with half a quintal of calcined borax and half a quintal of pulverised glass, in order to vitrify the adherent earths and stones which envelop the bismuth. But probably the heat requisite for this vitrification would volatilise part of the bismuth.

If the ore be of the kinds above described, mineralised by sulphur, or by sulphur and iron, a previous roasting would be expedient, which may be performed in the same manner as is directed for the roasting of antimony.

#### SECT. XI. Ores of the Regulus of Cobalt.

COBALT is a grey-coloured mineral, with more or less of a metallic appearance. Its grain is close; it is compact and heavy, and frequently covered with an efflorescence of peach-coloured flowers. Of this several kinds are known\*. All the true cobalts contain the semi-metal called *regulus* of cobalt, the calx of which becomes blue by vitrification. This regulus is mineralised in cobalt by sulphur, and especially by a large quantity of arsenic. Some cobalts also contain bismuth and silver.

Authors have given the name of *cobalt* to many minerals, although they do not contain the semi-metal above-mentioned, but only because they externally resemble the ore of the regulus of cobalt. But these minerals can only be considered as false cobalts. They are distinguishable from true cobalt by trying whether they can yield the blue glass called *smalt*; and the sympathetic ink. The red efflorescence is also a mark by which true cobalt is distinguishable from the false: but this efflorescence only happens when the ore has been exposed to a moist air.

The principal mines of cobalt are in Saxony, where they are dug for the sake of obtaining zaffre, azure-blue or smalt, and arsenic. Very fine cobalt is also found in the Pyrenean mountains. It has been likewise found in Cornwall and Scotland. And that it is in the eastern parts of Asia, appears from the blue colouring on old oriental porcelain: but probably the mines discovered in these countries are nearly exhausted, as considerable quantities of zaffre and smalt are exported from Europe to China.

Cobalt is heavier than most other ores, from the large quantity of arsenic it contains; and in this respect it resembles the ore of tin.

Besides the grey or ash-coloured cobalt above described, which is the most frequent, other cobalts are found of various colours and textures, mixed with various substances. Wallerius enumerates six species of cobalts. 1. The *ash-coloured ore*, which is regulus of cobalt mineralised by arsenic, consisting of shining leaden-coloured grains. Some ores of this kind are compact resembling steel, and others are of a loose texture and friable. 3. The *specular ore* is black, shining like a mirror, and laminated. This species is very rare; and is supposed by Wallerius to be a foliated spar, or selenites mixed with cobalt. 3. The *vitreous, or slag-like ore*, is of a bluish, shining colour, compact, or spongy. 4. *Crystallized ore*, is a grey, deep-colour-

ed cobalt, consisting of clusters of cubical, pyramidal, prismatic crystals. 5. *Flowers of cobalt*, red, yellow, or violet. These flowers seem to be formed from some of the above-described compact ores, decomposed by exposure to moist air. This decomposition is similar to that which happens to ferruginous and cupreous pyrites. 6. The *earthy cobalt* is of a greenish white, or of a yellow colour, and of a soft and friable texture. This species seems to be an ochre of cobalt; and is formed perhaps from the flowers of cobalt further decomposed, in the same manner as a martial ochre is formed from the saline efflorescence of decomposing pyrites, when this efflorescence is further decomposed by exposure to moist air; by which the vitriolic acid contained in it is expelled, and the efflorescence is changed from a saline state to that of an ochre or calx.

Besides these proper ores, cobalt is also found in a blue clay along with native silver, in ores of bismuth, and in the mineral called *kupfernicker*. See NICKEL.

The assay of cobalt is described at the article REGULUS of Cobalt.

#### SECT. XII. Ores of Zinc.

§ 1. THE proper ore of zinc is a substance which has rather an earthy or stony than metallic appearance, and is called *calamy*, *calamine*, or *lapis calaminaris*. This stone, although metallic, is but moderately heavy, and has not the brilliancy of most other ores. Its colour is yellow, and like that of rust. It is also less dense than other metallic minerals. It seems to be an ore naturally decomposed. The calamine is not worked directly to obtain zinc from it, because this would only succeed in close vessels, and consequently with small quantities, according to Mr Margraaf's process. But it is successfully employed for the conversion of copper into brass by cementation, by which the existence of zinc in that stone is sufficiently proved.

Mr Wallerius enumerates also amongst the ores of zinc a very compounded mineral, consisting of zinc, sulphur, iron, and arsenic. This mineral, called *blend*, resembles externally the ore of lead, and hence has been called *falſe galena*. These blends have different forms and colours; but are chiefly red, like the red ore of antimony.

Zinc is obtained from certain minerals in the East Indies, of which we know little.

*Calceiform ores* of zinc, according to Cronstedt, are pure or mixed. The pure are indurated, and sometimes crystallised, resembling lead-spar. The mixed ore contains also some calx of iron. This is *calamine*. It is whitish, yellowish, reddish, or brown.

Zinc is mineralised, 1. By *sulphurated iron*. Ore of zinc. Wallerius says, lead is sometimes contained in this ore. It is white, blue, or brown. 2. By *sulphur, arsenic, and iron*. *Blend*, or *pseudo-galena*, or *falſe-galena*, or *black-jack*. These are of various colours, white, yellowish, brown, reddish, greenish, black. They consist of scales, or are tessellated. Mr Cronstedt thinks, that in blends the zinc is mineralised in the state of a calx, and in the ore of zinc in its metallic state.

§ 2. Although the minerals above enumerated have been known, from their property of converting copper into brass, to be ores of zinc, yet the method of essaying

\* See  
Cobalt.

Ores of Zinc. saying them so as to obtain the contained zinc was not known, or at least not published, before Mr Margraaf's Memoir of the Berlin Academy for the year 1746, upon that subject. That very able chemist has shewn, that zinc may be obtained from its ores, from the flowers, or from any other calx of zinc, by treating these with charcoal dust, in close vessels, to prevent the combustion of the zinc, which happens immediately upon its reduction when exposed to air. For this purpose, he put a quantity of finely powdered calamine, or roasted blend, or other calx of zinc, well mixed with an eighth part of charcoal-dust, into a strong, luted earthen retort, to which he fitted a receiver. Having placed his retort in a furnace and raised the fire, he applied a violent heat during two hours. When the vessels were cold and broken, he found the zinc in its metallic form adhering to the neck of the retort.

The chief difficulty in this operation is to get an earthen retort sufficiently compact to retain the vapour of the zinc, (for it easily pervades the Hessian crucibles, Stourbridge melting-pots, and similar vessels, as may be seen from the quantity of flowers which appear upon their outer surface, when zinc or its calxes and any inflammable matter have been exposed to heat within these vessels) and at the same time sufficiently strong to resist the violent fire which Mr Margraaf requires.

A pretty exact assay of an ore of zinc may be made in the following manner.

Mix a quantity of pulverised roasted ore or calx of zinc with an eighth part of charcoal-dust. Put this mixture into a crucible capable of containing thrice the quantity. Diffuse equally amongst this mixture a quantity of small grains or thin plates of copper equal to that of the calamine or ore employed, and upon the whole lay another equal quantity of grains or plates of copper; and lastly, cover this latter portion of copper with charcoal-dust. Lute a lid upon the crucible; and apply a red heat during an hour or two. The copper or part of it will unite with the vapour of the zinc, and be thereby converted into brass. By comparing the weight of all the metal after the operation, with the weight of the copper employed; the weight acquired, and consequently the quantity of zinc united with the copper, will be known. The copper which has not been converted into brass, or more copper with fresh charcoal dust, may be again added in the same manner to the remaining ore, and the operation repeated with a heat somewhat more intense, that any zinc remaining in the ore may be thus extracted. A curious circumstance is, that a much greater heat is required to obtain zinc from its ore, by distillation, than in the operation now described of making brass; in which the separation of the zinc from its ore seems to be facilitated by its disposition to unite with copper.

### SECT. XIII. Ores of Arsenic.

§ 1. THE minerals which contain the largest quantity of arsenic are cobalts and white pyrites; although it is also contained in other ores, it being one of the mineralising substances. But as cobalt must be roasted to obtain the sulphur it contains, the arsenic also which rises during this torrefaction is collected, as we shall see in Part III. (SMELTING OF ORES,) and the particu-

lar articles of each of the metallic substances mentioned in this article.

I. Regulus of arsenic is found native. It is of a leaden colour; it burns with a small flame; and is dissipated, leaving generally a very small quantity of calx of bismuth, or of calx of cobalt, and a very little silver. When it is of a solid and testaceous texture, it has been improperly called *testaceous cobalt*, in German *scherbencobalt*. II. Calx of arsenic is found in form of powder; native flowers of arsenic, or of indurated transparent crystals; native crystalline arsenic. III. Calx of arsenic is mixed, 1. With sulphur: when yellow, it is called *orpiment*; when red, it is called *native realgar*: the difference of colour depends on the proportion of the two component parts. 2. With calx of tin; tin-grains. 3. With sulphur and silver, in the red silver ore. 4. With calx of lead, in the lead-spar. 5. With calx of cobalt, in the efflorescence of cobalt. IV. Arsenic is mineralised, 1. With sulphurated iron; arsenical pyrites. 2. With iron only; white pyrites, or mispickel. 3. With cobalt, in almost all cobalt-ores. 4. With silver. 5. With copper. 6. With antimony.

§ 2. Arsenic may be separated from its ore or earthy matter with which it happens to be mixed, by sublimation, according to the following process by Mr Cramer.

"Do every thing as was said about mercury, or sulphur; but let the vessel which is put into the fire with the ore in it be of earth or stone, and the recipient be of glass, and of a middling capacity. Nor is it necessary that this should be filled with water, so it be but well luted. The fire must likewise be stronger, and continued longer than for the extracting of sulphur. Nevertheless every kind of arsenic cannot be extracted in a confined fire: for it adheres to the matrix more strongly than sulphur and mercury. You will find in the part of the vessel which is more remote from the fire, pulverent and subtle flowers of arsenic; but there will adhere to the posterior of the neck of the retort small solid masses, shining like small crystals, transparent, sometimes gathered into a solid sublimate, and perfectly white, if the ore of the arsenic was perfectly pure; which, nevertheless, happens very seldom. The flowers are most commonly thin, and of a grey colour: which proceeds from the phlogiston mixed with the mass. They are often of a citron or of a golden colour, which is a sign that there is in the mixture some mineral sulphur; and if the sublimate be red or yellow, it is a sign of much sulphur.

"As all the arsenic contained in the ore is not expelled in close vessels, you must weigh the residuum; then roast it in a crucible till it smokes no longer, or rather in an earthen flat vessel not glazed, and in a strong fire to be stirred now and then with a poker, and then weigh it when grown cold; you will be able thus to know how much arsenic remained in the close vessel, unless the ore contain bismuth."

If the arsenic be sulphurated, it may be purified by triturating it with mercury or with fixed alkali, and by subliming the arsenic from the remaining sulphurated mercury or alkali. The method of obtaining a regulus of arsenic is described at the article *REGULUS of Arsenic*.

## P A R T III.

## S M E L T I N G O F O R E S.

Sulphur-works.

HAVING shown the nature of the principal metallic minerals, and the substances of which they are composed; and also explained the processes by which an exact analysis of these compound minerals may be made, and the nature and quantity of the contained metals may be known; in order to complete what relates to this important subject, we shall describe in this Part the principal operations by which metals, &c. are obtained "in the great," as it is called, or for commercial purposes. What we shall say upon this subject will chiefly be extracted from a *Treatise on the Smelting of Ores*, by Schlutter, translated from the German into French by M. Hellot; because this, of all the modern works upon that subject, appears to be the most exact. We shall first describe the operations upon pyritous matters for the extraction of sulphur, &c. and afterwards the operations by which metallic substances are extracted from *ores* properly so called.

SECT. I. *Extraction of Sulphur from Pyrites and other Minerals.*

IN order to obtain sulphur from pyrites, this mineral ought to be exposed to a heat sufficient to sublime the sulphur, or to make it distill in vessels, which must be close, to prevent its burning.

Sulphur is extracted from pyrites at a work at Schwartzemberg, in Saxony, in the high country of the mines; and in Bohemia, at a place called *Alten-Sattel*.

The furnaces employed for this operation are oblong, like vaulted galleries; and in the vaulted roofs are made several openings. These are called *furnaces for extracting sulphur*.

In these furnaces are placed earthen-ware tubes, filled with pyrites broken into pieces of the size of small nuts. Each of these tubes contains about 50 pounds of pyrites. They are placed in the furnace almost horizontally, and have scarcely more than an inch of descent. The ends, which come out of the furnace five or six inches, become gradually narrower. Within each tube is fixed a piece of baked earth, in form of a star, at the place where it begins to become narrower, in order to prevent the pyrites from falling out, or choking the mouth of the tube. To each tube is fitted a receiver, covered with a leaden plate, pierced with a small hole to give air to the sulphur. The other end of the tube is exactly closed. A moderate fire is made with wood, and in eight hours the sulphur of the pyrites is found to have passed into the receivers.

The residuum of the pyrites, after the distillation, is drawn out at the large end, and fresh pyrites is put in its place. From this residuum, which is called *burnings of sulphur*, vitriol is extracted.

The 11 tubes, into which were put, at three several distillations, in all nine quintals or 900 pounds of pyrites, yield from 100 to 150 pounds of crude sulphur, which is so impure as to require to be purified by a second distillation.

Sulphur-works.

This purification of crude sulphur is also done in a furnace in form of a gallery, in which five iron cucurbits are arranged on each side. These cucurbits are placed in a sloping direction, and contain about eight quintals and a half of crude sulphur. To them are luted earthen tubes, so disposed as to answer the purpose of capsals. The nose of each of these tubes is inserted into an earthen pot called the *fore-runner*. This pot has three openings; namely, that which receives the nose of the tube; a second smaller hole, which is left open to give air; and a third in its lower-part, which is stopped with a wooden peg.

When the preparations are made, a fire is lighted about seven o'clock in the evening, and is a little abated as soon as the sulphur begins to distil. At three o'clock in the morning, the wooden pegs which stop the lower holes of the *fore-runners* are for the first time drawn out, and the sulphur flows out of each of them into an earthen pot with two handles, placed below for its reception. In this distillation the fire must be moderated and prudently conducted; otherwise less sulphur would be obtained, and it also would be of a grey colour, and not of the fine yellow which it ought to have when pure. The ordinary loss in the purification of eight quintals of crude sulphur is, at most, one quintal.

When all the sulphur has flowed out, and has cooled a little in the earthen pots, it is cast into moulds made of beech-tree, which have been previously dipt in water and set to drain. As soon as the sulphur is cooled in the moulds, they are opened, and the cylinders of sulphur are taken out and put up in casks. These are called *roll-brimstone*.

As sulphur is not only in pyrites, but also in most metallic minerals, it is evident that it might be obtained by works in the great from the different ores which contain much of it, and from which it must be separated previously to their fusion: but as sulphur is of little value, the trouble of collecting it from ores is seldom taken. Smelters are generally satisfied with freeing their ores from it, by exposing them to a fire sufficient to expel it. This operation is called *torrefaction*, or *roasting of ores*.

There are, however, ores which contain so much sulphur, that part of it is actually collected in the ordinary operation of roasting, without much trouble for that purpose. Such is the ore of Ramelsberg in the country of Hartz.

This ore, which is of lead, containing silver, is partly very pure, and partly mixed with cupreous pyrites and silver; hence it is necessary to roast it.

The roasting is performed by laying alternate strata of ore and wood upon each other in an open field, taking care to diminish the size of the strata as they rise higher; so that the whole mass shall be a quadrangular pyramid truncated above, whose base is about 31 feet square. Below, some passages are left open, to give free entrance to the air; and the sides  
and

and top of the pyramid are covered over with small ore, to concentrate the heat and make it last longer. In the centre of this pyramid there is a channel which descends vertically from the top to the base. When all is properly arranged, ladfuls of red-hot scoria from the smelting-furnace are thrown down the channel, by which means the shrubs and wood placed below for that purpose are kindled, and the fire is from them communicated to all the wood of the pile, which continues burning till the third day. At that time the sulphur of the mineral becomes capable of burning spontaneously, and of continuing the fire after the wood is consumed.

When this roasting has been continued 15 days, the mineral becomes greasy; that is, it is covered over with a kind of varnish: 20 or 25 holes or hollows are then made in the upper-part of the pile in which the sulphur is collected. From these cavities the sulphur is taken out thrice every day, and thrown into water. This sulphur is not pure, but crude; and is therefore sent to the manufacturers of sulphur, to be purified in the manner above-related.

As this ore of Ramelsberg is very sulphureous, the first roasting, which we are now describing, lasts three months; and during this time, if much rain has not fallen, or if the operation has not failed by the pile falling down or cracking, by which the air has so much free access, that the sulphur is burnt and consumed, from 10 to 20 quintals of crude sulphur are by this method collected.

The sulphur of this ore, like that of most others, was formerly neglected, till, in the year 1570, a person employed in the mines called *Christopher Sauter*, discovered the method of collecting it, nearly as it is done at present.

Metallic minerals are not the only substances from which sulphur is extracted. This matter is diffused in the earth in such quantities, that the metals cannot absorb it all. Some sulphur is found quite pure, and in different forms, principally in the neighbourhood of volcanoes, in caverns, and in mineral waters. Such are the opaque kind called *virgin sulphur*; the transparent kind called *sulphur of Quito*; and the native flowers of sulphur, as those of the waters of Aix-la-Chapelle. It is also found mixed with different earths. Here we may observe, that all those kinds of sulphur which are not mineralized by metallic substances, are found near volcanoes, or hot mineral waters, and consequently in places where nature seems to have formed great subterranean laboratories, in which sulphureous minerals may be analyzed and decomposed, and the sulphur separated, in the manner in which it is done in small in our works and laboratories. However that be, certainly one of the best and most famous sulphur-mines in the world is that called *Solfatara*. The Abbé Nollet has published, in the Memoirs of the Academy, some interesting observations upon this subject, which we shall here abridge.

Near Puzzoli, in Italy, is that great and famous mine of sulphur and alum called at present *Solfatara*. It is a small oval plain, the greatest diameter of which is about 400 yards, raised about 300 yards above the level of the sea. It is surrounded by high hills and great rocks, which fall to pieces, and whose fragments

form very steep banks. Almost all the ground is bare and white, like marble; and is every-where sensibly warmer than the atmosphere in the greatest heat of summer, so that the feet of persons walking there are burnt through their shoes. It is impossible not to observe the sulphur there; for every-where may be perceived by the smell a sulphureous vapour, which rises to a considerable height, and gives reason to believe that there is a subterranean fire below, from which that vapour proceeds.

Near the middle of this field there is a kind of basin three or four feet lower than the rest of the plain, in which a fount may be perceived when a person walks on it, as if there were under his feet some great cavity, the roof of which was very thin. After that, the lake Agnano is perceived, whose waters seem to boil. These waters are indeed hot, but not so hot as boiling water. This kind of ebullition proceeds from vapours which rise from the bottom of the lake, which being set in motion by the action of subterranean fires, have force enough to raise all that mass of water. Near this lake there are pits, not very deep, from which sulphureous vapours are exhaled. Persons who have the itch, come to these pits, and receive the vapours in order to be cured. Finally, there are some deeper excavations, whence a soft stone is procured which yields sulphur. From these cavities vapours exhale, and issue out with noise, and which are nothing else than sulphur subliming through the crevices. This sulphur adheres to the sides of the rocks, where it forms enormous masses: in calm weather, the vapours may be evidently seen to rise 25 or 30 feet from the surface of the earth.

These vapours, attaching themselves to the sides of rocks, form enormous groups of sulphur, which sometimes fall down by their own weight, and render these places of dangerous access.

In entering the *Solfatara*, there are warehouses and buildings erected for the refining of sulphur.

Under a great shed, or hangar, supported by a wall behind, and open on the other three sides, the sulphur is procured by distillation from the soft stones we mentioned above. These stones are dug from under ground; and those which lie on the surface of the earth are neglected. These last are, however, covered with a sulphur ready formed, and of a yellow colour: but the workmen say they have lost their strength, and that the sulphur obtained from them is not of so good a quality as the sulphur obtained from the stones which are dug out of the ground.

These last mentioned are broken into lumps, and put into pots of earthen ware, containing each about 20 pints Paris measure. The mouths of these pots are as wide as their bottoms; but their bellies, or middle parts, are wider. They are covered with a lid of the same earth, well luted, and are arranged in two parallel lines along two brick walls, which form the two sides of a furnace. The pots are placed within these walls; so that the centre of each pot is in the centre of the thickness of the wall, and that one end of the pots overhangs the wall within, while the other end overhangs the wall without. In each furnace ten of these pots are placed; that is, five in each of the two walls which form the two sides of the furnace. Be-

twixt these walls there is a space of 15 or 18 inches; which space is covered by a vault resting on the two walls. The whole forms a furnace seven feet long, two feet and a half high, open at one end, and shut at the other, excepting a small chimney through which the smoke passes.

Each of these pots has a mouth in its upper part without the furnace, in order to admit a tube of 18 lines in diameter and a foot in length, which communicates with another pot of the same size placed without the building, and pierced with a round hole in its base of 15 or 18 lines diameter. Lastly, to each of these last-mentioned pots there is a wooden tub placed below, in a bench made for that purpose.

Four or five of these furnaces are built under one hangar, or shed. Fires are kindled in each of them at the same time; and they are thrown down after each distillation, either that the pots may be renewed, or that the residuums may be more easily taken out.

The fire being kindled in the furnace, heats the first pots containing the sulphureous stones. The sulphur rises in fumes into the upper part of the pot, whence it passes through the pipe of communication into the external vessel. There the vapours are condensed, become liquid, and flow through the hole below into the tub, from which the sulphur is easily turned out, because the form of the vessel is that of a truncated cone whose narrower end is placed below, and because the hoops of the tub are so fastened that they may be occasionally loosened. The mass of sulphur is then carried to the buildings mentioned before, where it is melted for its purification, and cast into rolls, such as we receive it.

*Extraction of VITRIOL from pyrites.* See CHEMISTRY, n<sup>o</sup> 110, 142, 157.

*Extraction of ALUM from pyritous substances and from aluminous earths.* See CHEMISTRY, n<sup>o</sup> 129.

## SECT. II. Smelting of Ores in general.

§ 1. As ores consist of metallic matters combined with sulphur and arsenic, and are besides intermixed with earthy and stony substances of all kinds, the intention of all the operations upon these compound bodies is to separate these different substances from each other. This is effected by several operations founded on the known properties of those substances. We now proceed to give a general idea of these several operations.

First of all, the ore is to be separated from the earths and stones accidentally adherent to it; and when these foreign substances are in large masses, and are not very intimately mixed in small particles with the ore, this separation may be accomplished by mechanical means. This ought always to be the first operation, unless the adherent substance be capable of serving as a flux to the ore. If the unmetallic earths be intimately mixed with the ore, this must necessarily be broken and divided into small particles. This operation is performed by a machine which moves pebbles, called *becards* or *stampers*. After this operation, when the parts of the mineral are specifically heavier than those of the unmetallic earth or stone, these latter may be separated from the ore by washing in canals through which water flows. With regard to this washing of ores, it is necessary to observe, that it cannot succeed but when the ore is sen-

sibly heavier than the foreign matters. But the contrary happens frequently, as well because quartz and spar are naturally very ponderous, as because the metallic matter is proportionally so much lighter as it is combined with more sulphur.

When an ore happens to be of this kind, it is necessary to begin by roasting it, in order to deprive it of the greatest part of its sulphur.

It happens frequently that the pyritous matters accompanying the ore are so hard that they can scarcely be pounded. In this case it is necessary to roast it entirely, or partly, and to throw it red-hot into cold water; by which the stones are split, and rendered much more capable of being pulverized.

Thus it happens very frequently, that roasting is the first operation to which an ore is exposed.

When the substance of the ore is very fusible, this first operation may be dispensed with, and the matter may be immediately fused without any previous roasting, or at least with a very slight one. For, to effect this fusion, it is necessary that it retain a great quantity of its sulphur, which, with the other fluxes added, serves to destroy or convert into scoria a considerable part of the stony matter of the mineral, and to reduce the rest into a brittle substance, which is called the *matt of lead*, or of *copper*, or other metal contained in the ore. This matt is therefore an intermediate matter betwixt the mineral and the metal; for the metal is there concentrated, and mixed with less useless matter than it was in the ore. But as this matt is always sulphureous, the metal which it contains cannot have its metallic properties. Therefore it must be roasted several times to evaporate the sulphur, before it is remelted, when the pure metal is required. This fusion of an ore not roasted, or but slightly roasted, is called *crude fusion*.

We may here observe upon the subject of washing and roasting of ores, that as arsenic is heavier than sulphur, and has nearly the weight of metals, the ores in which it prevails are generally very heavy, and consequently are susceptible of being washed, which is a great advantage. But on the other side, as arsenic is capable of volatilizing, scorifying, and destroying many metals, these ores have disadvantages in the roasting and fusion, in both which considerable loss is caused by the arsenic. Some ores contain, besides arsenic, other volatile semi-metals, such as antimony and zinc. These are almost untractable, and are therefore neglected. They are called *minera rapaces*, "rapacious ores."

When the metal has been freed as much as is possible from foreign matters by these preliminary operations, it is to be completely purified by fusions more or less frequently repeated; in which proper additions are made, either to absorb the rest of the sulphur and arsenic, or to complete the vitrification or scorification of the unmetallic stones and earth.

Lastly, as ores frequently contain several different metals, these are to be separated from each other by processes suited to the properties of these metals, of which we shall speak more particularly as we proceed in our examination of the ores of each metal.

§ 2. To facilitate the extraction of metallic substances from the ores and minerals containing them, some operations previous to the fusion or smelting of these

Roasting of Ores.

Fusion of Ores.

these ores and minerals are generally necessary. These operations consist of, 1. The *separation* of the ores and metallic matters from the adhering unmetallic earths and stones, by hammers and other mechanical instruments, and by washing with water. 2. Their *division* or reduction into smaller parts by contusion and trituration, that by another washing with water they may be more perfectly cleansed from extraneous matters, and rendered fitter for the subsequent operations, calcination or roasting, and fusion. 3. *Roasting or calcination*; the uses of which operation are, to expel the volatile, useless, or noxious substances, as water, vitriolic acid, sulphur, and arsenic; to render the ore more friable, and fitter for the subsequent contusion and fusion; and, lastly, to calcine and destroy the viler metals, for instance the iron of copper-ores, by means of the fire, and of the sulphur and arsenic. Stones, as quartz and flints, containing metallic veins or particles, are frequently made red-hot, and then extinguished in cold water, that they may be rendered sufficiently friable and pulverable, to allow the separation of the metallic particles.

Roasting is unnecessary for native metals; for some of the richer gold and silver ores; for some lead-ores, the sulphur of which may be separated during the fusion; and for many calciform ores, as these do not generally contain any sulphur and arsenic.

In the roasting of ores, the following attentions must be given, 1. To reduce the mineral previously into small lumps, that the surface may be increased; but they must not be so small, nor placed so compactly, as to prevent the passage of the air and flame. 2. The larger pieces must be placed at the bottom of the pile, where the greatest heat is. 3. The heat must be gradually applied, that the sulphur may not be melted, which would greatly retard its expulsion; and that the spars, fluors, and stones, intermixed with the ore, may not crack, fly, and be dispersed. 4. The ores not thoroughly roasted by one operation must be exposed to a second. 5. The fire may be increased towards the end, that the noxious matters more strongly adhering may be expelled. 6. Fuel which yields much flame, as wood and fossil coals free from sulphur, is said to be preferable to charcoal or coaks. Sometimes cold water is thrown on the calcined ore at the end of the operation, while the ore is yet hot, to render it more friable.

No general rule can be given concerning the duration or degree of the fire, these being very various according to the difference of the ores. A roasting during a few hours or days is sufficient for many ores; while some, such as the ore of Rammelberg, require that it should be continued during several months.

Schlutter enumerates five methods of roasting ores. 1. By constructing a pile of ores and fuel placed in alternate strata, in the open air, without any furnace. 2. By confining such a pile within walls, but without a roof. 3. By placing the pile under a roof, without lateral walls. 4. By placing the pile in a furnace consisting of walls and a roof. 5. By roasting the ore in a reverberatory furnace, in which it must be continually stirred with an iron rod.

Several kinds of fusions of ores may be distinguished. 1. When a sulphureous ore is mixed with much earthy matter, from which it cannot be easily separa-

ted by mechanical operations, it is frequently melted, in order to disengage it from these earthy matters, and to concentrate its metallic contents. By this fusion, some of the sulphur is dissipated, and the ore is reduced to a state intermediate betwixt that of ore and of metal. It is then called a *matte* (*lapis sulphureo-metallicus*); and is to be afterwards treated like a pure ore by the second kind of fusion, which is properly the smelting, or extraction of the metal by fusion. 2. By this fusion or smelting, the metal is extracted from the ore previously prepared by the above operations, if these be necessary. The ores of some very fusible metals, as of bismuth, may be smelted by applying a heat sufficient only to melt the metals, which are thereby separated from the adhering extraneous matters. This separation of metals by fusion, without the vitrification of extraneous matters, may be called *eliquation*. Generally, a complete fusion of the ore and vitrification of the earthy matters are necessary for the perfect separation of the contained metals. By this method, metals are obtained from their ores, sometimes pure, and sometimes mixed with other metallic substances, from which they must be afterwards separated; as we shall see, when we treat of the extraction of particular metals. To procure this separation of metals from ores, these must be so thinly liquefied, that the small metallic particles may disengage themselves from the scoria; but it must not be so thin as to allow the metal to precipitate before it be perfectly disengaged from any adhering extraneous matter, or to pervade and destroy the containing vessels and furnace. Some ores are sufficiently fusible; but others require certain additions called *fluxes*, to promote their fusion and the vitrification of their unmetallic parts; and also to render the scoria sufficiently thin to allow the separation of the metallic particles.

Different fluxes are suitable to different ores, according to the quality of the ore, and of the matrix, or stone adherent to it.

The matrixes of two different ores of the same metal frequently serve as fluxes to each other; as, for instance, an argillaceous matrix with one that is calcareous; these two earths being disposed to vitrification when mixed, though each of them is singly unfusible. For this reason, two or more different ores to be smelted are frequently mixed together.

The ores also of different metals require different fluxes. Thus calcareous earth is found to be best suited to iron-ores, and spars and scoria to fusible ores of copper.

The fluxes most frequently employed in the smelting of ores are, calcareous earth, fluors or vitreous spars, quartz and sand, fusible stones, as flates, basaltes, the several kinds of scoria, and pyrites.

*Calcareous earth* is used to facilitate the fusion of ores of iron, and of some of the poorer ores of copper, and, in general, of ores mixed with argillaceous earths, or with felspar. This earth has been sometimes added with a view of separating the sulphur, to which it very readily unites: but by this union the sulphur is detained, and a hepar is formed, which readily dissolves iron and other metals, and so firmly adheres to them, that they cannot be separated without more difficulty than they could from the original ore. This addition is therefore not to be made till the sulphur be previously

ously well expelled.

*Floors* or *fusible spars* facilitate the fusion of most metallic minerals, and also of calcareous and argillaceous earths, of limestones, albitus, and some other unfusible stones, but not of siliceous earths without a mixture of calcareous earth.

*Quartz* is sometimes added in the fusion of ferruginous copper ores, the use of which is said chiefly to be, to enable the ore to receive a greater heat, and to give a more perfect vitrification to the ferruginous scoria.

The *fusible stones*, *us flates*, *bassalters*, are so tenacious and thick when fused, that they cannot be considered properly as fluxes, but as matters added to lessen the too great liquidity of some very fusible minerals.

The *scoria* obtained in the fusion of an ore is frequently useful to facilitate the fusion of an ore of the same metal, and sometimes even of ores of other metals.

*Sulphurated pyrites* greatly promote the fusibility of the scoria of metals, from the sulphur it contains. It is chiefly added to difficultly-fusible copper-ores, to form the sulphureous compounds called *matts*, that the ores thus brought into fusion may be separated from the adhering earthy matters, and that the ferruginous matter contained in them may be destroyed, during the subsequent calcination and fusion, by means of the sulphur.

As in the ores called *calciform*, the metallic matter exists in a calcined state; and as calcination reduces the metals of mineralized ores (excepting the perfect metals) to that state also; therefore all calciform and calcined ores require the addition of some inflammable substance, to reduce them to a metallic state. In great works, the charcoal or other fuel used to maintain the fire produces also this effect.

*Metals* are sometimes added in the fusion of ores of other more valuable metals, to absorb from these sulphur or arsenic. Thus iron is added to sulphurated, cupreous, and silver ores. Metals are also added in the fusion of ores of other more valuable metals, to unite with and collect the small particles of these dispersed through much earthy matter, and thus to assist their precipitation. With these intentions, lead is frequently added to ores and minerals containing gold, silver, or copper.

*Ores of metals* are also sometimes added to assist the precipitation of more valuable metals. Thus antimony is frequently added to assist the precipitation of gold intermixed with other metallic matters. Thus far of smelting of ores in general.

### SECT. III. Operations on Ores of Native Gold and Silver, by Washing and by Mercury.

**EARTHS** and sand are at first separated by washing with water; by which operation the greatest part of what is not gold, being lighter, is carried off. After this a second washing is made with mercury, which having the property of uniting with gold, seizes this metal, amalgamates with it, and separates it exactly from the earthy matters, with all which it can form no union.

The mercury thus charged with gold is pressed through shamoy leather, and the gold is retained united with a part of the mercury, from which it may be easily disengaged by exposure to a proper degree of

heat, which dissipates and evaporates the mercury, while the gold, being fixed, remains.

This is the foundation of all the operations by which gold is obtained from the rich mines of Peru belonging to the Spaniards. These operations consist in washings, triturations, and amalgams in the great by help of machines.

The ores of native silver are much rarer and less abundant than those of gold. But if any of this kind were found sufficiently rich, they might be treated with mercury exactly in the same manner as the ores of native gold.

Gold is frequently contained in the ores of other metals, either in a native or mineralized state, and in sands, especially those which are black and ferruginous. See Part II. sect. of *Ores of Gold*.

If *gold* be contained in *ores of other metals*, these metals together with the gold may be first extracted by the ordinary processes for smelting these ores; and the gold may be then separated from the metallic mass thus obtained, by mixing and fusing this mass with a quantity of lead, and by the process of cupellation described in the articles *ESSAY of the value of silver*, and *REFINING*. Generally, the operations for obtaining gold from ores of imperfect metals are precisely the same as those for obtaining silver, to which therefore we refer. Most frequently a quantity of silver also is contained in these ores; and in this case the perfect metal obtained by cupellation is an alloy of gold and silver, which must be afterwards separated by the processes called *parting*. See *PARTING*.

Many trials have been made to procure the small quantity of gold contained in the *ferruginous sands*, at a moderate expence (see Part II. sect. of *Ores of Gold*); but as no work of this kind is now established, we may presume they have not been successful. The best essays of this kind have been made, according to Schlutter, in the following manner.

The sand is to be made red-hot, and extinguished in cold water four times, by which its colour is changed from the original yellow, red, or black, to a reddish-brown. It is observed to emit, during the first and second calcinations, an arsenical smell; and this smell may be produced again in the following calcinations by adding some inflammable matter. Let an ounce of the calcined sand be mixed with two ounces of granulated lead, and one ounce of black flux, and put into a Hessian crucible, with half an ounce of decrepitated sea-salt upon the surface of the mixture. The crucible is to be placed in a good blast-furnace, and a strong fire is to be excited. The matter contained in the crucible is to be frequently stirred with an iron-rod, and the heat is to be continued till the scoria is thin and perfectly fused. When the crucible is broken, a regulus of lead will be found, containing the gold and silver of the sand. By this method Mr Leberrecht obtained, in eleven essays, from 840 to 844 grains of perfect metal from a quintal of sand. Of the perfect metal obtained, from a fourth to a third part was gold. Some parcels of sand have yielded more than 1000 grains, and some not more than 350 grains, per quintal. Instead of the granulated lead, and the black flux, which is too expensive for great operations, some have added, to an ounce of the sand, two ounces of litharge and.



Smelting  
of Ores of  
Silver.Smelting  
of Ores of  
Silver.

and a little powder of charcoal, by which they have obtained the same quantity of perfect metal. The scoria in these effays has been always found to contain some perfect metal.

The Hungarian copper ores, from which gold and silver are profitably extracted, contain a less quantity of these perfect metals than many ferruginous sands. But they may be formed into a matt, by fusion with pyrites, of which treatment the sands are incapable. From this matt, the gold and silver, along with the copper of the ore, may be precipitated, and separated from the sulphur of the pyrites, by addition of iron, which being more disposed than the other metals to unite with sulphur, disengages these metals, and allows them to precipitate.

#### SECT. IV. *Smelting of Ores of Silver.*

§ 1. As silver, even in its proper ores, is always alloyed with some other metals from which it is intended to be separated after that the silver-ore has been well roasted, it must be mixed with a greater or less quantity of lead previous to its fusion.

Lead has the same effect in fusion of gold and silver as mercury has upon these metals by its natural fluidity; that is to say, it unites with them, and separates them from unmetallic matters, which, being lighter, rise always to the surface. But lead has the further advantage of procuring, by its own vitrification, that of all metallic substances, excepting gold and silver. Hence it follows, that when gold and silver are obtained by means of mercury, they still remain alloyed with other metallic substances; whereas when they are obtained by fusion and scorification with lead, they are then pure, and not alloyed with any metals but with each other.

In proportion as the lead, which has been united to the gold and silver of the ore, is scorified by the action of the fire, and promotes the scorification of the other metallic matters, it separates the perfect metals, and carries with it all the others to the surface. There it meets the unmetallic substances, which it likewise vitrifies, and which it changes into a perfect scoria, fluid, and such as a scoria ought to be to admit all the perfect metal contained in it to precipitate.

When all heterogeneous matters have been thus disengaged by scorification with lead, the perfect metals, to which some lead still remains united, are to be further purified by the ordinary operation of the cupel.

The common rule for the fusion and scorification of silver-ore with lead, is to add to the ore a quantity of lead so much greater as there is more matter to be scorified, and as these matters are more refractory and of more difficult fusion. Silver ores, or those treated as such, are often rendered refractory by ferruginous earths, pyritous matters, or cobalts, containing always a considerable quantity of an earth which is unmetallic, very subtle, and very refractory, and which renders a considerable augmentation of the quantity of lead necessary.

The quantity of lead which is commonly added to fusible silver ores, that do not contain lead, is eight times the quantity of the ore. But when the ore is refractory, it is necessary to add twelve times the

quantity of lead, and even more; also glass of lead, and fluxes, such as the white and black fluxes; to which however borax and powder of charcoal are preferable, on account of the liver of sulphur formed by these alkaline fluxes.

It is necessary to observe, that saline fluxes are only used in small operations, on account of their dearth. To these are substituted, in the great operations, of which we now treat, sandiver, fusible scoria, and other matters of little value.

The greatest part of silver now employed in commerce is not obtained from the proper ores of silver, which are very scarce; but from lead, and even copper ores, which are more or less rich in silver. To give an idea of the manner of treating these kinds of ores, from which silver is extracted in the great works, we shall briefly describe here, after Schlutter, the smelting of the ore of Rammelsberg, which contains, as we have already said, several different kinds of metals, but particularly lead and silver.

When this mineral has been disengaged from its sulphur as much as possible by three very long roastings, it is melted in the Lower Hartz in Saxony, in a particular kind of furnace, called a *furnace for smelting upon a hollow or casse*. The masonry of this furnace is composed of large thick slates, capable of sustaining great heat, and cemented together by clay. The interior part of the furnace is three feet and a half long, and two feet broad at the back part, and one foot only in the front. Its height is nine feet eight inches. It has a foundation of masonry in the ground; and in this foundation channels are made for the evaporation of the moisture. These channels are covered over with stones called *covering stones*. The hollow or casse, which is made above these, is formed of bricks, upon which are placed, first, a bed of clay; then a bed of small ore and sifted vitriols; and, lastly, a bed of charcoal-powder beat down, called *light braque*. The anterior wall of the furnace is thinner than the others, and is called the *chemise*. The back wall, which is pierced to give passage to the pipes of two large wooden bellows, is called the *middle-wall*. When the furnace is thus prepared, charcoal is thrown into the hollow, or casse; which being kindled, the fire is to be continued during three hours, before the matters to be fused are added. Then these matters are thrown in, which are not the pure ore, but a mixture of several substances, all of which are somewhat profitable. The quantity of these matters is sufficient for one day's work; that is, for a fusion of eighteen hours; and it consists of, 1. Twelve schorbens or measures of well roasted Rammelsberg ore; (the schorben is a measure whose contents are two feet five inches long, one foot seven inches broad, and a little more than a foot deep: it is equal to 32 quintals of that country, Cologn weight, at 123 pounds each quintal.) 2. Six measures of scoria produced by the smelting of the ore of Upper Hartz, which is refractory, and what workmen call *collé*. 3. Two measures of knobben, which is an impure scoria containing some lead and silver, which has been formerly thrown away as useless, and is now collected by women and children. Besides these, other matters are added, containing lead and silver, as the tests employed in refining, the dross of lead, impure litharge, and

and any rubbish containing metal, which was left in the furnace after the foregoing fusion. All these matters being mixed together, are thrown into the furnace: and to each measure of this mixture a measure of charcoal is added. The fusion is then begun by help of bellows; and as it proceeds, the lead falls through the light braque, or charcoal-bed, into the hollow, or casse, where it is preserved from burning under the powder of charcoal. The scoria, on the other hand, being lighter and less fluid, is skimmed off from time to time by means of ladles, that it may not prevent the rest of the lead from falling down into the hollow. Thus, while the fusion lasts, fresh matters and fresh charcoal are alternately added, till the whole quantity intended for one fusion, or, as they call it, one *day*, be thrown in.

There are several essential things to be remarked in this operation, which is very well contrived. First, The mixture of matters from which a little lead and silver is procured, which would otherwise be lost; and which have also this advantage, that they retard the fusion of the Ramelsberg ore, which, however well roasted it has been, retains always enough of the sulphur and iron of the pyrites mixed with it, to render it too fusible or too fluid, so that without the addition of those matters nothing would be obtained but a matt. It is even necessary, notwithstanding these additions, not to hasten the fusion too much, but to give time for the ore to mix with other matters, else it would melt and flow of itself before the rest. Secondly, The fusion of the ore through charcoal, which is practised in most smelting-houses, and for almost all ores, is an excellent method, the principal advantage of which is the saving of fuel. The action of the burning charcoal directed immediately upon the mineral, at the same time that it melts it more readily and efficaciously, also supplies it with the phlogiston necessary to bring it to a perfect state.

From the Ramelsberg ore after its first roasting, a *white vitriol* is obtained and prepared at Goslar<sup>a</sup>, whose basis was *zinc*: which proves that this ore contains also a certain quantity of this semi-metal. As this ore is smelted in a country where the art is well understood of extracting every thing which a mineral contains, so in this fusion *zinc* and *cadmia* are obtained in the following manner: When the furnace is prepared for the fusion, it is necessary to close it up in the fore-part, before the fusion is begun.

“First of all, a gritt-stone is to be placed, supported at the height of three inches. This stone is as long as the furnace is broad, and the height of it is level with the hole where the bellows-pipe enters. It is fastened on each side of the furnace, externally and internally, with clay. Upon this stone a kind of receptacle, or, as it is called, the *seat of the zinc*, is made in the following manner: A flat slaty stone is chosen, as long as the furnace is broad, and eight inches in breadth. This is placed on the gritt-stone above-mentioned, in such a manner that it inclines considerably towards the front of the furnace, and that its bottom touches closely the gritt-stone. It is fastened with clay, which is also laid upon the seat of the zinc. Upon this seat, which is to receive the zinc, two round pieces of charcoal are placed,

and also a stone called the *zinc stone*, which is about a foot and a half in length, and closes one part of the front of the furnace. This stone also is fastened on each of its sides with clay. Clay is likewise put under the stone betwixt the two pieces of charcoal, which hinder it from touching the seat of the zinc. The under-part of this stone is but slightly luted, that the workmen may make an opening for the zinc to flow out. Thus is made the seat or receptacle of the zinc to detain this metallic substance, which would otherwise fall into the hottest part of the fire, called by the workmen the *melting-place*, and would be there burnt: whereas it is collected upon this receptacle during the fusion, where it is sheltered from the action of the bellows, and consequently from too great heat.

“When all the matter to be fused in one day is put into the furnace, the blast of air is continued till that matter has sunk down. When it is half-way down the furnace, they draw out the scoria, that more of the ore and other matters may be exposed to the greatest heat. As soon as the scoria is cooled and fixed a little, two shovel-fulls of small wet scoria or sand is thrown close to the furnace, and beat down with the shovel; then the workmen open the seat or receptacle of zinc, and strike upon the zinc-stone to make the semi-metal flow out. As soon as the purest part of it has flowed out, it is sprinkled with water and carried away. Then the workmen separate entirely the zinc-stone from the wall of the furnace, and they continue to give it little strokes, that the small particles of zinc dispersed among the charcoal may fall down. This being done, the stone is removed; and the zinc is separated from the charcoal by an iron instrument, is cleaned, and remelted along with the zinc that flowed out at first, and is cast into round cakes. The reason why the zinc is withdrawn before the bellows cease to blow, is, that if it was left till the charcoal on the seat or receptacle was consumed, it would be mostly burnt, and little would be obtained. Thus after the zinc is withdrawn, the fusion is finished by blowing the bellows till the end.”

Thus the zinc is separated from the ore of Ramelsberg, and is not confounded in the hollow or casse with the lead and silver, because, being a volatile semi-metal, it cannot support the activity of the fire without rising into vapours, which are condensed in the place least hot, that is to say, upon the stones expressly prepared for that purpose; and which, being much thinner than the other walls of the furnace, are continually cooled by the external air.

It is also in this furnace, and after the fusion of the Ramelsberg ore, that the *cadmia of zinc*, or the *cadmia of furnaces*, is obtained. This ore is composed of sulphureous and ferruginous pyrites, of true lead-ore containing silver, and a very hard and compact matter of a dark brownish-grey colour, which is probably a *lapis calaminaris*, or an ore of zinc. These several matters of the Ramelsberg ore are not separated from each other, either for the roasting or for the fusion. Thus there is zinc in all the parts of the roasted ore; and much more of it would be obtained, if it was not so easily inflammable. All the zinc which is obtained is preserved from burning by falling, while

<sup>a</sup> See  
Chemistry,  
no 157.

Smelting  
of Ores of  
Silver.Fining of  
Silver.

while in fusion, behind the chemise or fore-part of the furnace, which is, as has been said, a kind of schistus or slate, called by the workmen *steel-stone*. But the part of this semi-metal which falls in the middle of the furnace, near the middle-wall, or towards the sides, being exposed to the greatest heat of the fire, is there burnt; and its smoke or flowers attaching itself on all sides to the walls of the furnace, undergo there a semi-fusion, which renders this matter so hard and so thick, that it must be taken away after every fourth fusion, or, at most, after every sixth fusion. That which is found attached to the highest part of the furnace is the best and purest. The rest is altered by a mixture of a portion of lead which it has carried up with it; and which, from its great weight and fixity, has hindered the zinc from rising so high as it would have done alone. Therefore, with this kind of impure cadmia, ductile brass cannot be made.

Almost all the zinc we have, as well as the cadmia of the furnaces, is obtained from the Ramelsberg ore, by the process described, and consequently is not the produce of a pure ore of zinc, or *lapis calaminaris*, which is never used for that purpose. Before Mr Margraaf, although it was well known that this ore contained zinc, and that it was employed for the making of brass, a convenient process for extracting zinc from it was not known; because, when treated by fusion with fluxes, like other ores, it does not yield any zinc; which proceeds partly from the refractory quality of the earth contained in the calamine, that cannot be fused without a very violent fire; and also from the volatility and combustibility of the zinc, which for this reason cannot be collected at the bottom of a crucible, as a regulus under a scoria, like most metals.

M. Margraaf has remedied these inconveniences by distilling *lapis calaminaris*, mixed with charcoal, in a retort, to which is joined a receiver containing some water, and consequently in close vessels, where the zinc, by the help of a very strong fire indeed, is sublimed in its metallic form without burning. He also by the same method reduced into zinc the *flowers of zinc*, or *zinnpholis*, *cadmia of the furnaces*, *tutty*, which is also a kind of cadmia; in a word, all matters capable of producing zinc by combination with phlogiston.—But it is evident that such operations as these are rather fit to supply proofs for chemical theory, than to be put in practice for works in great. M. Margraaf has observed, that the zinc which he obtained by this process was less brittle than what is obtained from the fusion of ores; which may proceed from its greater purity, or from its better combination with phlogiston.

Zinc is obtained, not only in the method used at Goslar above-described; but is also extracted in great works, from *lapis calaminaris* and calcined blend, by a distillation similar to that by which M. Margraaf has essayed ores of zinc. The first work of that kind was erected in Sweden by Mr Van Swab, in the year 1738. The ore employed was a kind of blend; this ore, when calcined, powdered, and mixed with charcoal, was put into iron or stone retorts, and the zinc was obtained by distillation. In Bristol a work is established in which zinc is obtained by distillation *by descent*.

After this digestion which we have now made concerning the operation in the great by which zinc and cadmia are obtained, and which we could not insert elsewhere, because of the necessary relation it has with the smelting of the Ramelsberg ore, we proceed to the other operations of the same ore; that is to say, to the *finery*, by which the silver is separated from the lead, which are mixed together, forming what is called the *work*.

This operation differs from the *fining of assay*, or *in small*, principally in this circumstance, that in the latter method of fining all the litharge is absorbed into the cupel, whereas in the former method the greatest part of this litharge is withdrawn.

The fining in great of the work of Ramelsberg is performed in a furnace called a *reverberatory furnace*. This furnace is so constructed that the flame of wood burning in a cavity called the *fire-place*, is determined by a current of air (which is introduced through the ash-hole, and which goes out at an opening on one side of that part of the furnace where the work is, that is, where the lead and silver are) to circulate above, and to give the convenient degree of heat, when the fire is properly managed. In this furnace a great cupel, called a *test*, is disposed. This test is made of the ashes of beech-wood, well lixiviated in the usual manner. In some founderies different matters are added, as sand, spar, calcined gypsum, quicklime, clay. When the test is well prepared and dried, all the work is put at once upon the cold test, to the quantity of 64 quintals for one operation. Then the fire is lighted in the fire-place with faggots; but the fusion is not urged too fast, 1. That the test may have time to dry; 2. Because the work of the Ramelsberg ore is alloyed by the mixture of several metallic matters, which it is proper to separate from it, otherwise they would spoil the litharge and the lead procured from it. These metallic matters are, copper, iron, zinc, and matt. As these heterogeneous substances are hard and refractory, they do not melt so soon as the work, that is, as the lead and silver; and when the work is melted, they swim upon its surface like a skin, which is to be taken off. These impurities are called the *scum*, or the *first-waste*. What remains forms a second scum, which appears when the litharge is at its greatest degree of heat, but before the litharge begins to form itself. It is a scoria which is to be carefully taken off. It is called the *second waste*.

When the operation is at this point, it is continued by the help of bellows, the wind of which is directed, not upon the wood or fuel, but upon the very surface of the metal, by means of iron-plates put for that purpose before the blast-hole, which are called *papillons*. This blast does not so much increase the intensity of the fire, as it facilitates the combustion of the lead, and throws the litharge that is not imbibed by the test towards a channel, called the *litharge way*, through which it flows. The litharge becomes fixed out of the furnace: the matter which is found in the middle of the largest pieces, and which amounts to about a half or a third of the whole, is friable, and falls into powder like sand. This is put into barrels containing each five quintals of it; and is called *saleable litharge*, because it is sold in that state. The other part which remains solid is called *cold litharge*, and is again melted

and

and reduced into lead. The fusion is called *cold fusion*, and the lead obtained from it *cold lead*, which is good and saleable when the work has been well cleared from the heterogeneous matters mentioned above. The tests and cupels impregnated with litharge are added in the fusion of the ore, as we have already related.

When two thirds, or nearly that quantity, of the lead are converted into litharge, no more of it is formed. The silver then appears covered with a white skin, which the miners call *lightening*, and the metal *lightened* or *fined silver*.

The silver obtained by this process of fining is not yet altogether pure. It still contains some lead, frequently to the quantity of four drams in each marc, or eight ounces. It is delivered to the workmen, who complete its purification by the ordinary method. This last operation is the refining, and the workmen employed to do it are called *refiners*. A fining of 64 quintals of work, yields from 8 to 10 merces of fined silver, and from 35 to 40 quintals of litharge; that is, from 12 to 18 of saleable litharge, from 22 to 23 of cold litharge, from 20 to 22 quintals of impregnated test, and from 6 to 7 quintals of lead-drops. The operation lasts from 16 to 18 hours.

§ 2. Ores containing silver may be divided into four kinds, 1. Pure, or those which are not much compounded with other metals. 2. Galenical, in which the silver is mixed with much galena, or ore of lead mineralised by sulphur. 3. Pyritous, in which the silver is mixed with the martial pyrites. 4. Cupreous; in which the silver is contained in copper ores. To extract the silver from these several kinds of ores, different operations are necessary.

Native silver is separated from its adhering earths and stones by amalgamation with mercury, in the manner directed for the separation of gold; or by fusion with lead, from which it may be afterwards separated by cupellation.

Pure ores seldom require a previous calcination; but, when bruised and cleaned from extraneous matters, may be fused directly, and incorporated with a quantity of lead; unless they contain a large proportion of sulphur and arsenic, in which case a calcination may be useful. The lead employed must be in a calcined or vitrified state, which, being mixed with the ore, and gradually reduced by the phlogiston of the charcoal added to it, may be more effectually united with the silver of the ore, than if lead itself had been added, which would too quickly precipitate to the bottom of the containing vessel or furnace. The silver is to be afterwards separated from the lead by cupellation.

Galenical ores, especially those in which pyrites is intermixed, require a calcination, which ought to be performed in an oven, or reverberatory furnace. They are then to be fused together with some inflammable matter, as charcoal, by which the lead is revived, and together with the silver, is precipitated.

Pyritous ores must be first melted, so as to form a matt. If the sulphur is not sufficient for this kind of fusion, more sulphurated pyrites may be added. This matt contains, besides silver and sulphur, also various metals, as lead, iron, and sometimes cobalt. The matt must be exposed to repeated calcinations till the

sulphur is diffipated. By these calcinations most of the iron is destroyed. The calcined matt is to be fused with litharge, and the silver incorporated with the revived lead; from which, and from the other imperfect metals with which it may be mixed, it must afterwards be separated by cupellation.

The silver contained in cupreous ores may be obtained, either, 1. By separating it from the copper itself, after this has been extracted along with the silver, in the usual manner, from the ore; or, 2. By precipitating it immediately, from the other matters of the ore.

1. It may be separated from the copper by two methods. One of these is by adding lead, and scorifying the imperfect metals. By this method much of the copper would be destroyed, and it is therefore not to be used unless the quantity of silver relatively to the copper be considerable. Another method by which silver may be separated from copper is, by eliquation; that is, by mixing the mass of copper and silver with a quantity of lead, and applying such a heat as shall be just sufficient to make the lead eliquate from the copper, together with the silver, which being more strongly disposed to unite with the lead than with the copper, is thus incorporated with the former metal, and separated from the latter.

2. Silver may also be extracted from these cupreous ores by precipitation. For this purpose, let the ore, previously bruised and cleaned, be formed into a matt, that the earthy matters may be well separated. Let the matt be then fused with a strong heat; and when the scoria has been removed, and the heat is diminished, add to it some clean galena, litharge, and granulated lead. When the fire has been raised, and the additions well incorporated with the matt, let some cast or filed iron be thrown into the liquid mass, which, being more disposed than lead is to unite with sulphur, will separate and precipitate the latter metal, and along with it the silver or gold contained in the matt. This method was introduced by Scheffer, and is practised at Adelfors in Smoland. In this work the proportion of the several materials is, four quintals of matt, two quintals of black copper containing some lead with the perfect metal, one quintal of galena, one quintal of litharge, a fifth part of a quintal of granulated lead, and an equal quantity of cast iron.

The silver in this, and in all other instances where it is united with lead, is to be afterwards separated from the lead by cupellation; which process is described at the articles *ESSAY of the Value of Silver*, and *REFINING*.

#### SECT. V. *Smelting of Ores of Copper.*

§ 1. The smelting in great of copper ores, and even of several ores of silver and lead, excepting that of Ramelberg, is performed in furnaces not essentially different from that already described; but in this respect only, that the scoria and metal are not drawn out of the furnace, but flow spontaneously, as soon as they are melted, into receiving basons, where the metal is freed from the scoria. These furnaces are generally called *pierced furnaces*.

Instead of a light braque, or bed of charcoal-powder, under which the metal lies hid, the bottom of these furnaces is covered with a bason composed of

Smelting  
of Ores of  
Copper.

heavy brasque, which is a mixture of charcoal-powder and clay. In the front of the furnace, and at the bottom of the chemise, there is a hole, called the *eye*, through which the melted matter flows, and runs along a trench or furrow, called the *trace*, into one or more receiving basons, made of earth, scoria, sand, &c. There the metal is separated from the scoria, by making it flow from these basons into another lateral one. These furnaces are also called *crooked furnaces*.

Different names are given to them according to some difference in their construction. For instance, those which have two eyes, and two traces, through which the melted matter flows alternately into two basons, are called  *spectacle-furnaces* . Their greater or less height gives occasion also to the distinction of *high furnaces*, and *middle furnaces*.

The high furnaces are of modern invention. They were first introduced at Mansfeldt in the year 1727; and they are now used in almost all countries where ores are smelted, as in Saxony, Bohemia, Hungary, &c. Their chief advantage consists in simplifying and diminishing the labour. This advantage is effected by the great height of the furnace, which allows the ore to remain there a long time before it falls down into the hottest part of the fire and is melted. Consequently, it suffers successively different degrees of heat; and, before it is melted, it undergoes a roasting which costs nothing: therefore the high furnaces are chiefly employed for crude fusions; and particularly for the slate-copper ore. These furnaces are above 18 feet high. A too great height is attended with an inconvenience, besides the trouble of supplying it with ore and fuel, which is, that the charcoal is mostly consumed before it gets down where the greatest heat is required, and is then rendered incapable of maintaining a fire sufficiently intense.

All the furnaces which we have mentioned are supplied with large bellows, moved by the arbor of a wheel, which is turned round by a current of water.

The only kind of furnace for smelting ores where bellows are not employed, is what is called a *reverberatory furnace*. The Germans call it a *wind-furnace*. It is also distinguished by the name of *English furnace*, because the invention of it is attributed to an English physician of the name of *Wright*, who was well versed in chemistry; and because the use of it was first introduced in England about the end of the last century, where it is much employed, as well as in several other countries, as at *Konigsberg*, in Norway.

The length of these furnaces is about 18 feet, comprehending the masonry: their breadth is 12 feet, and their height nine feet and a half. The hearth is raised three feet above the level of the foundry: on one side is the fire-place, under which is an ash-hole hollowed in the earth; on the other side is a bason made, which is kept covered with fire when there is occasion: on the anterior side of this furnace there is a chimney, which receives the flame after it has passed over the mineral that is laid upon the hearth. This hearth, which is in the interior part of the furnace, is made of a clay capable of sustaining the fire. The advantage of this furnace is, that bellows are not necessary; and consequently it may be constructed where there is no

current of water, and wherever the mine happens to be. This furnace has a hole in its front, through which the scoria is drawn out; and a bason, as we have said, on one side, made with sand, in which are oblong traces for the reception of the matt, and of the black copper, when they flow out of the furnace.

Copper is generally mineralised, not only by sulphur and arsenic, but also by semimetals and pyritous matters, and is frequently mixed with other metals. As this metal has great affinity with sulphur and arsenic, it is almost impossible to disengage it from them entirely by roasting: hence, in the smelting in great, nothing is obtained by the first operation but a copper matt, which contains all the principles of the ore, excepting the earthy and stony parts, particularly when the ore is smelted crude and unroasted. Afterwards this matt must be again roasted and fused. The produce of this second fusion begins still more to resemble copper, but is not malleable. It continues mixed with almost all the minerals, particularly with the metals. As it is frequently of a black colour, it is always called *black copper*, when it is unmanageable, whatever its colour happens really to be.

As, of all the imperfect metals, copper is most difficultly burnt and scorified, it is again remelted several times, in order to burn and scorify the metallic substances mixed with it; and this is done till the copper is perfectly pure, which is then called *red* or *refined copper*, and these last fusions are called the *fining* and *refining* of it: red copper contains no metals but gold and silver, if any of these happened to be in the ore.

In order to avoid all these fusions, it has been proposed to treat in the humid way certain copper ores, particularly those which are very pyritous. This method consists in making blue vitriol from the ore, by roasting and lixiviating it, and in precipitating pure copper from this lixivium, which is called *cement-water*, by means of iron: but it is not much practised, because it has been observed, that all the copper contained in the ore was not procured by this means.

As expence is not much regarded in small essays and experiments, these fusions are much abridged and facilitated by adding at first saline and glassy fluxes; and then by refining the black copper with lead in the cupel, as gold and silver are done. In this method of refining, it is to be most carefully observed, that the metal be fused as quickly as possible, and exposed to no more heat than is necessary, lest it be calcined.

When the black copper contains some iron, but not a great deal, the lead presently separates the iron from it, and makes it rise to the surface of the copper: but if the iron be in too large a proportion, it prevents the lead from uniting with the copper. These two phenomena depend on the same cause, which is, that lead and iron cannot unite.

Frequently copper ores contain also a quantity of silver sufficient to make its extraction by particular processes profitable. It was long before any process could be thought of for this purpose which was not too expensive and troublesome: but at length it is accomplished by the excellent operation called *eliquation*.

The copper from which silver has been separated by eliquation must be refined after this operation, as it is generally black copper from which silver is extracted: but even if it had not been black copper which was employed for this operation, it would require to be refined on account of a little lead it always retains. It is therefore carried to the refiners furnace, when this operation is performed by help of bellows, the blast of which is thrown upon the surface of the melted metal. As in this refining of copper the precise time when it becomes pure cannot be known, because scoria is always formed on its surface, it is necessary to use an assay-iron, the polished end of which being dipt in melted copper, shews that this metal is pure when the copper adhering to the iron falls off as soon as it is dipt in cold water.

When this mark of the purity of the copper has been observed, its surface ought to be well cleaned; and as soon as it begins to fix, it must be sprinkled with a broom or bescam dipped in cold water. The surface of the copper which is then fixing, being suddenly cooled by the water, detaches itself from the rest of the metal, is taken hold off by tongs, and is thrown red-hot into cold water. By again sprinkling water on the mass of copper, it is all of it reduced into plates which are called *rosettes*, and these plates are what is called *rosette-copper*.

§ 2. The copper of pyritous cupreous ores cannot be obtained without several operations, which vary according to the nature of the ores. These operations are chiefly roastings and fusions. By the first fusion a matt is produced, which is afterwards to be roasted; and thus the fusions and roastings are to be alternately applied, till by the last fusion copper is obtained. These methods of treating pyritous copper ores depend on the two following facts: 1. Sulphur is more disposed to unite with iron than with copper. 2. The iron of these ores is destructible by the burning sulphur during the roasting or the fusion of the ores, while the copper is not injured. This fact appears from experiments mentioned by Scheffer and by Wallerius, and from the daily practice of smelting cupreous ores.

From these facts we learn, 1. That sulphur may be employed to separate and destroy iron mixed with copper. 2. That iron may be employed to separate the sulphur from copper, as is sometimes done in the assay of sulphurated copper-ores. 3. That by adjusting the proportion of the iron and sulphur to each other in the smelting of copper-ores, these two substances may be made to destroy each other, and to procure a separation of the copper: and this adjustment may be effected, by adding sulphur or sulphureous pyrites to the copper-ore, when the quantity of sulphur contained in this ore relatively to the iron is too small; or by adding iron when the sulphur predominates; or by roasting, by which the superfluous sulphur may be expelled, and no more left than is sufficient for the destruction of the iron contained in the ore. We shall apply these principles to the following cases.

1. When the quantity of sulphur and of iron in a copper-ore is small, and especially when the iron does not too much abound, a previous roasting will at once calcine the iron, and expel most of the sulphur; so that by one fusion the calcined iron may be scorified, and black copper may be obtained. If the sulphur has not

been sufficiently expelled, a second roasting and fusion are requisite; for the whole quantity of sulphur ought not to be expelled during the first roasting: but as much ought to be left as is sufficient for the scorification of the calcined iron; otherwise this might, during the fusion, be again revived and united with the copper.

2. If, in a copper-ore, the quantity of iron be too great, relatively to the sulphur, some sulphurated pyrites, especially that kind which contains copper, ought to be added, that a matt may be obtained, and that the iron may be calcined and scorified.

3. When the quantity of sulphur and iron is very great, that is, when the ore is very pyritous and poor, it ought to be first formed into a matt; by which it is separated from the adherent earths and bones, and the bulk is diminished: then by repeated and alternate roastings and fusions, the copper may be obtained.

4. When the quantity of sulphur in an ore is greater than is sufficient for the forming a matt, the superfluous quantity ought to be previously expelled by roasting.

The copper thus at first obtained is never pure, but is generally mixed with sulphur or with iron. It is called *black copper*. This may be refined in furnaces, or on hearths.

In the former method, to the copper when melted a small quantity of lead is added, which unites with the sulphur, and is scorified together with the iron, and floats upon the surface of the melted copper. This purification of copper by means of lead is similar to the refining of silver by cupellation; and is founded on the property of lead, by which it is more disposed to unite with sulphur than copper is; and on a property of copper, by which it is less liable than any other imperfect metal to be scorified by lead. But as copper is also capable of being scorified by lead, this operation must be no longer continued, and no more lead must be employed, than is sufficient for the separation of the sulphur, and for the scorification of the iron.

The copper might also be purified from any remaining sulphur by adding a sufficient quantity of iron to engage the sulphur. Thus Mr Scheffer found, that by adding to sulphurated copper from  $\frac{1}{3}$ th to  $\frac{1}{2}$ th of old cast iron, he rendered the copper pure and ductile. See his Dissertation on the Parting of Metals amongst the *Swedish Memoirs* for the year 1752. In this purification, the quantity of iron added ought not to be too little, else all the sulphur will not be separated; and it ought not to be too great, else the superfluous quantity will unite with and injure the purity of the copper. The fusion and scorification, with addition of lead, seems to be the best method for the last purification of copper.

#### SECT. VI. *Smelting, &c. of Ores of Iron.*

NOTWITHSTANDING the great importance of this subject, and the labours of Reaumur, Swedenborgius, and of some other authors, we have still a very imperfect knowledge of the causes of the differences of the several kinds of ores, of the methods of smelting best adapted to these differences, of the causes of the good and bad qualities of different kinds of iron, and of the means of so meliorating this metal that we may obtain tough and ductile iron from any of its ores.

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Manufacturing of Iron.

Swedenborgius has very industriously and exactly described the different processes now used in most parts of Europe for the smelting of ores of iron, for the forging of that metal, and for the conversion of it into steel; but we do not find that he or any other author have, by experiments and discoveries, contributed much to the illustration or to the improvement of this part of metallurgy, unless, perhaps, we except those of Mr. Reaumur, concerning the softening of cast iron by cementation with earthy substances.

The ores of iron are known to vary much in their appearance, in their contents, in their degrees of fusibility, in the methods necessary for the extraction of their contained metal, and in the qualities of the metal when extracted.

Most ores require to be roasted previously to their fusion; some more slightly, and others with a more violent and longer-continued fire. Those which contain much sulphur, arsenic, or vitriolic acid, require a long-continued and repeated roasting, that the volatile matters may be expelled. Of this kind is the black-iron ore, from which the Swedish iron is said to be obtained.

Some ores require a very slight roasting only, that they may be dried and rendered friable. Such are the ores called *hog ores*, and others, which being in a calcined state, and containing little sulphureous matter, would, by a further calcination, be rendered less capable of being reduced to a metallic state.

The roasting of ores of iron is performed by kindling piles, consisting of strata of fuel and of ore placed alternately upon one another, or in furnaces similar to those commonly employed for the calcination of lime-stone.

Some authors advise the addition of a calcareous earth to sulphureous ores during the roasting, that the sulphur may be absorbed by this earth when converted into quicklime. But we may observe, that the quicklime cannot absorb the sulphur or sulphureous acid, till these be first extricated from the ore, and does therefore only prevent the dissipation of these volatile matters; and, secondly, that the sulphur thus united with the quicklime forms a heap of sulphur, which will unite with and dissolve the ore during its fusion, and prevent the precipitation of the metal.

The next operation is the *fusion* or *smelting* of the ore. This is generally performed in furnaces or towers, from 20 to 30 feet high, in the bottom of which is a basin for the reception of the fluid metal. When the furnace is sufficiently heated, which must be done at first very gradually, to prevent the cracking of the walls; a quantity of the ore is to be thrown in, from time to time, at the top of the furnace, along with a certain quantity of fuel and of lime-stone, or whatever other flux is employed. While the fuel below is consumed by the fire excited by the wind of the bellows, the ore, together with its proportionable quantity of fuel and of flux, sink gradually down, till they are exposed to the greatest heat in the furnace. There the ore and the flux are fused, the metallic particles are revived by the fuel, are precipitated by means of their weight through the scoria formed of the lighter earthy parts of the flux and of the ore, and unite in the basin at the bottom of the furnace, forming a mass of fluid metal covered

by a glassy scoria. When a sufficient quantity of this fluid metal is collected, which is generally twice or thrice in 24 hours, an aperture is made, through which the metal flows into a channel or groove made in a bed of sand; and from thence into smaller lateral or connected channels, or other moulds. There it is cooled, becomes solid, and retains the forms of the channels or moulds into which it flows. The piece of iron formed in the large channel is called a *cow*, and those formed in the smaller channels are called *figs*. Sometimes the fluid iron is taken out of the furnace by means of ladles, and poured into moulds ready prepared, of sand or of clay, and is thus formed into the various utensils and instruments for which cast iron is a proper material.

The *scoria* must be, from time to time, allowed to flow out, when a considerable quantity of it is formed, through an aperture made in the front of the furnace for that purpose. A sufficient quantity of it must, however, be always left to cover the surface of the melted iron, else the ore which would fall upon it, before the separation of its metallic from its unmetallic parts, would lessen the fluidity and injure the purity of the melted metal. This scoria ought to have a certain degree of fluidity; for if it be too thick, the revived metallic particles will not be able to overcome its tenacity, and collect together into drops, nor be precipitated. Accordingly, a scoria not sufficiently fluid, is always found to contain much metal. If the scoria be too thin, the metallic particles of the ore will be precipitated before they are sufficiently metallized, and separated from the earthy and unmetallic parts. A due degree of fluidity is given to the scoria by applying a proper heat, and by adding fluxes suited to the ore.

Some ores are fusible without addition, and others cannot be smelted without the addition of substances capable of facilitating their fusion.

The *fusible ores* are those which contain sulphur, arsenic, or are mixed with some fusible earth.

The *ores difficultly fusible* are those which contain no mixture of other substance. Such are most of the ores which contain iron in a state nearly metallic. As iron itself, when purified from all heterogeneous matters, is scarcely fusible without addition, so the metal contained in these purer kinds of ores cannot be easily extracted without the addition of some fusible substance. 2. Those which are mixed with some very refractory substance. Some of these refractory ores contain arsenic; but as this substance facilitates the fusion of iron, we may presume that their refractory quality depends upon a mixture of some unmetallic earth or other unfusible substance. The earth which is mixed with the common calciferous ores is in considerable quantity; and is sometimes calcareous, sometimes siliceous, and sometimes argillaceous.

Perhaps the fusibility of different ores depends greatly on the degree of calcination to which the metal contained in them has been reduced; since we have reason to believe, that, by a very perfect calcination, some metals at least may be reduced to the state of an earth almost unfusible, and incapable of metallization; and since we know, that in every calcination and subsequent reduction of a given quantity of any

imperfect metal, a sensible part of that quantity is always lost or destroyed, however carefully these operations may have been performed. That some of these ores are already too much calcined, appears from the instance above-mentioned of the *bog ores*, which are injured by roasting; and even the great height of the common smelting furnaces, although advantageous to many ores that require much roasting, is said to be injurious to those which are already too much calcined, by exposing them to a further calcination, during their very gradual descent, before they arrive at the hottest part of the furnace, where they are fused.

But as too violent calcination renders some ores difficultly fusible, so too slight calcination of other ores injures the purity of the metal, by leaving much of the sulphureous or other volatile matter, which ought to have been expelled.

Various substances are added to assist the fusion of ores difficultly fusible. These are, 1. Ores of a fusible quality, or which, being mixed with others of a different quality, become fusible: accordingly, in the great works for smelting ores of iron, two or more different kinds of ore are commonly mixed, to facilitate the fusion, and also to meliorate the quality of the iron. Thus an ore yielding an iron which is brittle when hot, which quality is called *red-short*, and another ore which produces iron brittle when cold, or *cold-short*, are often mixed together; not, as sometimes supposed, that these qualities are mutually destructive of each other, but that each of them is diminished in the mixed mass of iron, as much as this mass is larger than the part of the mass originally possessed of that quality. Thus, if from two such ores the mass of iron obtained consists of equal parts of cold-short and of red-short iron, it will have both these qualities, but will be only half as *cold-short* as iron obtained solely from one of the ores, and half as *red-short* as iron obtained only from the other ore. 2. Earths and stones are also generally added to facilitate the fusion of iron ores. These are such as are fusible, or become fusible when mixed with the ore, or with the earth adhering to it. Authors direct that, if this earth be of an argillaceous nature, limestone or some calcareous earth should be added; and that, if the adherent earth be calcareous, an argillaceous or siliceous earth should be added; because these two earths, though singly unfusible, yet, when mixed, mutually promote the fusion of each other: but as limestone is almost always added in the smelting of iron ores, and as in some of these, at least, no argillaceous earth appears to be contained, we are inclined to believe, that it generally facilitates the fusion, not merely by uniting with those earths, but by uniting with that part of the ore which is most perfectly calcined, and least disposed to metallization; since we know, that by mixing a calciferous or roasted ore of iron with calcareous earth, without any inflammable matter, these two substances may be totally vitrified. See *Experiments made upon quicklime and upon iron, by Mr Brandt, in the Swedish Memoirs for the years 1749 and 1751*. Calcareous earth does indeed so powerfully facilitate the fusion of iron ores, that it deserves to be considered whether workmen do not generally use too great a quantity of it, in order to hasten the

operation. For when the scoria is rendered too thin, much earthy or unmetallized matter is precipitated, and the cast iron produced is of too vitreous a quality, and not sufficiently approximated to its true metallic state.

Some authors pretend, that a principal use of the addition of limestone in the smelting of iron ores is to absorb the sulphur, or vitriolic acid, of these ores: but, as we have already observed, a heap of sulphur is formed by that mixture of calcareous earth and sulphur, which is capable of dissolving iron in a metallic state; and thus the quantity of metal obtained from an ore not sufficiently divested of its sulphur, or vitriolic acid, (which, by uniting with the fuel, is formed into a sulphur during the smelting,) must be considerably diminished, though rendered purer, by addition of calcareous earth: hence the utility appears of previously expelling the sulphur and vitriolic acid from the ore by a sufficient roasting. 3. The scoria of former smeltings is frequently added to assist the fusion of the ore; and, when the scoria contains much iron, as sometimes happens in ill-conducted operations, it also increases the quantity of metal obtained.

The quantity of these fusible matters to be added varies according to the nature of the ore; but ought in general to be such, that the scoria shall have its requisite degree of thinness, as is mentioned above.

The fuel used in most parts of Europe for the smelting of ores of iron is charcoal. Lately, in several works in England and Scotland, iron ore has been smelted by means of pit-coal, previously reduced to cinders or coaks, by a kind of calcination similar to the operation for converting wood into charcoal, by which the aqueous and sulphureous parts of the coal are expelled, while only the more fixed bituminous parts are left behind. In France, pit-coal not calcined has been tried for this purpose, but unsuccessfully. The use of peat has also been introduced in some parts of England.

The quality of the iron depends considerably upon the quality and also upon the quantity of the fuel employed. Charcoal is fitter than coaks for producing an iron capable of being rendered malleable by forging.

The quantity of fuel, or the intensity of the heat, must be suited to the greater or less fusibility of the ore. Sulphureous, and other ores easily fusible, require less fuel than ores difficultly fusible. In general, if the quantity of fuel be too small, and the heat not sufficiently intense, all the iron will not be reduced, and much of it will remain in the scoria, which will not be sufficiently thin. This defect of fuel may be known by the blackness and compactness of the scoria; by the qualities of the iron obtained, which in this case is hard, white, light, intermixed with scoria, smooth in its texture, without scales or grains, rough and convex in its surface, and liable to great loss of weight by being forged; and, lastly, it may be known by observing the colour and appearance of the drops of metal falling down from the melted ore, and of the scoria upon the surface of the fluid metal, both which are darker-coloured than when more fuel is used. When the quantity of fuel is sufficiently large, and the heat is intense enough, the iron is darker-coloured,



coloured, denser, more tenacious, contains less scoria, and is therefore less fusible, and loses less of its weight by being forged. Its surface is also smoother and somewhat concave; and its texture is generally granulated. The scoria, in this case, is of a lighter colour, and less dense. The drops falling down from the smelted ore and the liquid scoria in the furnace appear hotter and of a brighter colour. When the quantity of fuel is too great, and the heat too intense, the iron will appear to have a still darker colour, and more conspicuous grains or plates, and the scoria will be lighter, whiter, and more spongy. The drops falling from the smelted ore, and the fluid scoria, will appear to a person looking into the furnace through the blast-hole to be very white and shining hot. The quantity of charcoal necessary to produce five hundred weight of iron, when the ore is rich, the furnace well contrived, and the operation skillfully conducted, is computed to be about 40 cubic feet; but is much more in contrary circumstances.

The times, during which the fluid metal ought to be kept in fusion before it is allowed to flow out of the furnace, must be also attended to. How long that time is, and whether it ought not to vary according to the qualities of ores and other circumstances, we cannot determine. In some works the metal is allowed to flow out of the furnace every six or eight, and in others only every 10 or 12, hours. Some workmen imagine, that a considerable time is necessary for the concoction of the metal. This is certain, that the iron undergoes some change by being kept in a fluid state; and that if its fusion be prolonged much beyond the usual time, it is rendered less fluid, and also its cohesion, when it becomes cold, is thereby greatly diminished. The marquis de Courtivron says, that the cohesion may be restored to iron in this state, by adding to it some vitrescible earth, which he considers as one of the constituent parts of iron, and which he thinks is destroyed by the fusion too long continued. That the fusibility of cast iron does depend on an admixture of some vitrescible earth, appears probable from the great quantity of scoria forced out of iron during its conversion into malleable or forged iron, and from the loss of fusibility which it suffers nearly in proportion to its loss of scoria. The quantity of iron daily obtained from such a furnace as is above described, is from two to five tons in 24 hours, according to the richness and fusibility of the ore, to the construction of the furnace, to the adjustment of the due quantity of flux and of fuel, and to the skill employed in conducting the operation.

The quality of the iron is judged by observing the appearances during its flowing from the furnace, and when it is fixed and cold. If the fluid iron, while it flows, emits many and large sparkles; if many brown spots appear on it while it is yet red-hot; if, when it is fixed and cold, its corners and edges are thick and rough, and its surface is spotted; it is known to have a red-short quality. If, in flowing, the iron seems covered with a thin glassy crust, and if, when cold, its texture be whitish, it is believed to be cold-short. Mr Reaumur says, that dark-coloured cast iron is more impure than that which is white. The marquis de Courtivron is of a contrary opinion. But no certain rules for judging of the quality of iron before it

be forged can be given. From brittle cast iron, sometimes ductile forged iron is produced. Cast iron with brilliant plates and points, when forged, becomes sometimes red-short and sometimes cold-short. Large shining plates, large cavities called eyes, want of sufficient density, are almost certain marks of bad iron; but whether it will be cold or red-short cannot be affirmed till it be forged. Whiteness of colour, brittleness, closeness of texture, and hardness, are given to almost any cast iron by sudden cooling; and we may observe, that in general the whiter the metal is, the harder it is also, whether these properties proceed from the quality of the iron, or from sudden cooling; and that, therefore, the darker-coloured iron is fitter for being cast into moulds, because it is capable in some measure of being filed and polished, especially after it has been exposed during several hours to a red-heat in a reverberatory furnace, and very gradually cooled. This operation, called by workmen *annealing*, changes the texture of the metal, renders it softer, and more capable of being filed than before, and also considerably less brittle.

Mr Reaumur found, that by cementing cast iron with absorbent earths in a red-heat, the metal may be rendered softer, tougher, and consequently a fit material for many utensils formerly made of forged iron. Whether cementation with absorbent earths gives to cast iron a greater degree of these properties than the annealing commonly practised, has not been yet determined.

In Navarre, and in some of the southern parts of France, iron-ore is smelted in furnaces much smaller, and of a very different construction from those above described. A furnace of this kind consists of a wide-mouthed copper-caldron, the inner surface of which is lined with masonry a foot thick. The mouth of the caldron is nearly of an oval or elliptic form. The space or cavity contained by the masonry is the furnace in which the ore is smelted. The depth of this cavity is equal to two feet and a half: the larger diameter of the oval mouth of the cavity is about eight feet, and its smaller diameter is about six feet: the space of the furnace is gradually contracted towards the bottom, the greatest diameter of which does not exceed six feet: eighteen inches above the bottom is a cylindrical channel in one of the longer sides of the caldron and masonry, through which the nozzle of the bellows passes. This channel, and also the bellows-pipe, are so inclined, that the wind is directed towards the lowest point of the opposite side of the furnace. Another cylindrical channel is in one of the shorter sides of the furnace, at the height of a few inches from the bottom, which is generally kept closed, and is opened occasionally to give passage to the scoria; and above this is a third channel in the same side of the furnace, through which an iron instrument is occasionally introduced to stir the fluid metal, and to assist, as is said, the separation of the scoria from it. The greatest height of this channel is at its external aperture on the outside of the furnace, and its smaller height is at its internal aperture; so that the instrument may be directed towards the bottom of the furnace; but the second channel below it has a contrary inclination, that, when an opening is made, the scoria may flow out of the furnace into a

basin placed for its reception. When the furnace is heated sufficiently, the workmen begin to throw into it alternate changes of charcoal, and of ore previously roasted. They take care to throw the charcoal chiefly on that side at which the wind enters, and the ore at the opposite side. At the end of about four hours a mass of iron is collected at the bottom of the furnace, which is generally about 600 weight; the bellows are then stopp'd: and when the mass of iron is become solid, the workmen raise it from the bottom of the furnace, and place it, while yet soft, under a large hammer, where it is forged. The iron produced in these furnaces is of the best quality; the quantity is also very considerable, in proportion to the quantity of ore, and to the quantity of fuel employed. In these furnaces no limestone or other substance is used to facilitate the fusion of the ore. We should receive much instruction concerning the smelting of iron-ore, if we knew upon what part of the process, or circumstance, the excellence of the iron obtained in these furnaces depends; whether on the quality of the ore; or on the diffise of any kind of flux, by which the proportion of vitreous or earthy matter, intermixed with the metallic particles, is diminished; on the forging while the iron is yet soft and hot, as the Marquis de Courtivron thinks; or on some other cause, not observed.

The iron thus produced by smelting ores is very far from being a pure metal; and though its fusibility renders it very useful for the formation of cannon, pots, and a great variety of utensils, yet it wants the strength, toughness, and malleability, which it is capable of receiving by further operations.

Cast-iron seems to contain a large quantity of vitreous or earthy matter mixed with the pure iron; which matter is probably the chief cause of its fusibility, brittleness, hardness, and other properties by which it differs from forged iron. The sulphur, arsenic, and other impurities of the ore, which are sometimes contained in cast-iron, are probably only accidental, and may be the cause of the red-short quality, and of other properties of certain kinds of iron; but the earthy matter above-mentioned seems principally to distinguish cast-iron from forged or malleable iron; for, first, by depriving the former of this earthy matter, it is rendered malleable, as in the common process hereafter to be described; and, secondly, by fusing malleable iron with earthy and vitrescible matters, it loses its malleability, and is restored to the state and properties of cast-iron.

The earthy vitreous matter contained in cast-iron consists probably of some of the ferruginous earth or calx of the ore not sufficiently metallized, and also of some unmetallic earth. Perhaps it is only a part of the scoria which adheres to, and is precipitated with, the metallic particles, from which it is more and more separated, as the heat applied is more intense, and as the fusion is longer continued.

To separate these impurities from cast-iron, and to unite the metallic parts more closely and compactly, and thus to give it the ductility and tenacity which render this metal more useful than any other, are the effects produced by the following operations.

The first of these operations is a fusion of the iron, by which much of its impurities is separated in form of scoria; and by the second operation, a further and

more complete separation of these impurities, and also a closer compaction of the metallic particles, are effected by the application of mechanical force or pressure, by means of large hammers.

Some differences in the construction of the forge or furnace, in which the *fusion* or *refining* of cast-iron is performed, in the method of conducting the operation, and in other circumstances, are observed to occur in different places. We shall describe from Swedenborgius the *German method*.

The fusion of the cast-iron, which is to be rendered malleable, is performed upon the hearth of a forge similar to that used by blacksmiths: at one side of this hearth is formed a cavity or fire-place, which is intended to contain the fuel and the iron to be melted: this fire-place is 20 inches long, 18 inches broad, and 12 or 14 inches deep: it is bounded on three sides by three plates of cast-iron placed upright; and on the fourth side, which is the front, or that part nearest to which the workmen stand, by a large forge-hammer, through the eye of which the scoria is at certain times allowed to flow. The floor also of the fire-place is another cast-iron plate. The thickness of these plates is from two to four inches. One of the upright side-plates rests against a wall, in an aperture through which a copper tube, called the *tuyere*, is luted with clay. This tube is a kind of case or covering for the pipe of a pair of bellows placed behind the wall, and its direction is therefore parallel to that of the bellows-pipe; but it advances about half a foot further than this pipe into the fire-place; and thus gives greater force to the air, which it keeps concentrated, or prevents the divergency of the air, till it is required to act. The tube rests upon the edge of the side-plate which leans against the wall, nearer to the back-part than to the front of the fire-place, and in such an oblique direction, that the wind shall be impelled towards the furthest part of the floor of the fire-place, or where this floor is intersected by the opposite side-plate. The obliquity of the tuyere ought to vary according to the quality of the iron: and therefore, in every operation, it may be shifted till its proper position is found. The more nearly its direction approaches to a horizontal plane, the more intense is the heat; but a larger quantity of fuel is consumed than is even proportional to the increase of heat, because the flame is not then so well confined. When the iron is easily fusible, great heat is not required: the tuyere may then decline considerably from the horizontal plane, and thus fuel may be saved. This tuyere, tho' made of copper, a metal more easily fusible than iron, is preserved from fusion by the constant passage of cold air through it. It must be carefully kept open, and cleansed from the scoria, which would be apt to block up its cavity, by which not only the heat would be too much diminished for the success of the operation, but the tube itself would be melted.

To prepare for the fusion, a quantity of scoria of a former operation is thrown into the fire-place, till one-third part of this be full; and the remaining two-thirds of the fire-place are to be filled with smaller scoria, coal-dust, and sparks ejected from hot iron. These matters, being fusible, form a bath for the reception of the iron when melted. Upon this bed of scoria, the mass of cast-iron to be melted is placed;

so that one end of it shall be within the fire-place, opposite to the tuyere, and at the distance of about four or five inches from its aperture; and the other end shall stand without the fire-place, to be pushed in, as the former is melted. The upper side of the mass of iron ought to be in the same horizontal plane as the upper part of the orifice of the tuyere, that the wind may, by means of the obliquity of its course, strike upon and pass along the under-side of the mass; but if the iron be difficultly fusible, the tuyere is to be disposed more horizontally, so that the wind shall strike directly upon the mass of iron; and that one part of the blast shall graze along the upper surface, and the other part along the under surface of the iron. The mass of iron weighs generally from 200 to 400 pounds. Sometimes two or three smaller masses are put one above another, so as not to touch. When these are of different qualities, the cold-short piece is placed undermost, that being more unfusible than the red-short. The iron being placed, charcoal-powder is thrown on both sides, and coals are accumulated above, so as to cover entirely the iron.

The coals are then to be kindled, and the bellows are made to blow, at first slowly, and afterwards with more and more force. The iron is gradually liquefied, and flows down in drops through the melted scoria to the bottom of the fire-place; during which the workmen frequently turn the iron, so that the end opposed to the blast of wind may be equally exposed to heat, and uniformly fused. While the coals are consumed, more are thrown on, so that the whole may be kept quite covered. During the operation, a workman frequently sounds the bottom and corners of the fire-place by means of a bar or poker, raises up any mass of metal which he finds adhering to these, and exposes them to the greatest heat, that they may be more perfectly fused.

When all the iron is fused, no more coals are to be added; but the melted mass is to remain half uncovered for some time; during which the iron boils and bubbles, and its surface swells and rises higher and higher. When the iron has risen as high as the upper edge of the fire-place, the coals upon its surface must be removed; and by thus exposing it to cold air, its ebullition and swelling subside. In this state, or coction, the iron is kept during half an hour or more, by adding occasionally pieces of good coal, which maintain a sufficient heat, without covering entirely the surface of the mass. During this coction, the workmen allow the orifice of the tuyere to be half stopped up by the scoria, that the air may not blow upon the iron with all its force, by which it would be too much cooled. Accordingly, when they think that the coction has continued sufficiently long, they clear the passage of the tuyere, and the mass is soon cooled by the cold air. At the same time also, they open a passage in the eye of the hammer placed in the front of the fire-place, through which some of the scoria is allowed to flow out. When the iron has become solid, the bellows are stopt, the coals are removed, and the mass is left during an hour; and then the workmen raise it from the fire-place, turn it upside down, and proceed to the second coction or fusion of the iron.

From this second operation, the mass is to be so placed, that one part of it shall rest upon the tuyere,

and the other upon the scoria remaining in the fire-place. This scoria is to be disposed in an oblique direction parallel to the tuyere, by which means the wind of the bellows is obliged to pass along the under side of the mass of iron. About the sides of the mass, charcoal-powder and burnt ashes are thrown; and towards the tuyere, dry and entire pieces of coals are placed, to maintain the fire. When these are kindled, more coals are added, and the fire is gradually excited. The workman attends to the direction of the flame, that it pass equally along the under surface of the iron, quite to the further extremity, and that it do not escape at the sides, nor be reverberated back towards the tuyere, by which this copper tube might be melted. During this fusion, pieces of iron are apt to be separated from the mass, and to fall down unfused to the bottom and corners of the fire-place. These are carefully to be searched for, and exposed to the greatest heat till they are melted. When the whole mass is thus brought into perfect fusion, the coals are removed; and the wind blowing on its surface, whirls and dissipates the small remaining pieces of scoria, and sparks thrown out from the fluid iron. This jet of fire continues about seven or eight minutes, and the whole operation about two hours. In this second fusion the scoria is to be thrice removed, by opening a passage through the eye of the hammer. The first time of removing the scoria is about 20 minutes from the kindling of the fire, the second time is about 40 minutes after the first, and the third time is near the end of the operation.

The mass is then removed from the hearth, and put upon the ground of the forge, where it is cleaned from scoria, and beat into a more uniform shape. It is then placed on an anvil, where, by being forged, it receives a form nearly cubical. This mass is to be divided into five, six, or more pieces, by means of a wedge; and these are to be heated and forged till they are reduced to the form of the bars commonly sold.

In some forges, the iron is fused only once, and in others it suffers three fusions, by which it is said to be rendered very pure. Where only one fusion is practiced, it is called the *French method*. In this, no greater quantity of iron is fused at once than is sufficient to make one bar. The fire-place is of considerable less dimensions, and especially is less deep, than in the German method above described. The fire is also more intense, and the proportion of fuel consumed to the iron is greater. The iron, when melted, is not kept in a state of ebullition as is above described; but this ebullition is prevented by stirring the fluid mass with an iron bar, till it is coagulated, and becomes solid.

By these operations, fusion and forging, the iron loses about  $\frac{1}{3}$  parts of its former weight, sometimes more and sometimes less, according to the quality of the cast-iron employed; it is purified from the vitreous and earthy parts which were intermixed with it, its metallic particles are more closely compacted, its texture is changed, and it is rendered more dense, soft, and malleable, tough, and difficultly fusible.

The degrees, however, of these qualities vary much in different kinds of iron. Thus some iron is tough and malleable, both when it is hot and when it is cold.

This is the best and most useful iron. It may be known generally by the equable surface of the forged bar, which is free from transverse fissures or cracks in the edges, and by a clear, white, small-grained, or rather fibrous texture. Another kind is tough when it is heated, but brittle when it is cold. This is called *cold-short* iron; and is generally known by a texture consisting of large, shining plates, without any fibres. It is less liable to rust than other iron. A third kind of iron, called *red-short*, is brittle when hot, and malleable when cold. On the surface and edges of the bars of this kind of iron, transverse cracks or fissures may be seen; and its internal colour is dull and dark. It is very liable to rust. Lastly, some iron is brittle both when hot and when cold.

Most authors agree, that the red-short quality of iron proceeds from some sulphur or vitriolic acid being contained in it, because sulphur is known to produce this effect when added to iron, and because the iron obtained from pyrites and other sulphurated ores has generally this quality.

The cause of the cold-short quality of iron is not so well ascertained. Some imagine, that it proceeds from a mixture of arsenic or of antimony. But this opinion seems to be improbable, when we consider that these metallic substances may in a great measure be dissipated by roasting, whereas the ores which yield a cold-short iron are injured by much roasting; that no arsenic or antimony are observable in most, if in any, of these ores; and lastly, that these semi-metals would render the iron brittle both when hot and when cold. Cramer and other authors impute this vicious quality to a mixture of an unmetallic earth or vitreous matter; and affirm, that it may be destroyed by cementation with phlogiston, and by forging. And lastly, others ascribe the cold-short quality of iron to a defect of phlogiston, or, as Swedborgius says, of sulphur. To ascertain the causes of the bad qualities of iron, and to discover practical remedies, are still desiderata in metallurgy.

In one bar frequently two or more different kinds of iron may be observed, which run all along its whole length; and scarcely a bar is ever found of entirely pure and homogeneous iron. This difference probably proceeds from the practice we have mentioned of mixing different kinds of ores together, in the smelting; and also from the practice of mixing two or more pigs of cast iron of different qualities in the finery of these; by which means, the red-short and cold-short qualities of the different kinds are not, as we have already remarked, mutually counteracted or destroyed by each other, but each of these qualities is diminished in the mixed mass of iron, as much as this mass is larger than the part of the mass originally possessed of that quality: that is, if equal parts of red-short and of cold-short iron be mixed together, the mixed mass will be only half as red-short as the former part, and half as cold-short as the latter. For these different kinds of iron seem as if they were only capable of being interwoven and diffused thro' each other, but not of being intimately united or combined.

The quality of forged iron may be known by the texture which appears on breaking a bar. The best and toughest iron is that which has the most fibrous texture, and is of a clear greyish colour. This li-

brous appearance is given by the resistance which the particles of the iron make to their rupture. The next best iron is that whose texture consists of clear, whitish, small grains, intermixed with fibres. These two kinds are malleable, both when hot and when cold, and have great tenacity. *Cold-short* iron is known by a texture consisting of large, shining plates, without fibres: and *red-short* iron is distinguished by its dark dull colour, and by the transverse cracks and fissures on the surface and edges of the bars. The quality of iron may be much improved by violent compression, as by forging and rolling; especially when it is not long exposed to too violent heat, which is known to injure, and at length to destroy its metallic properties.

For the conversion of iron into *steel*, see the article STEEL.

#### SECT. VII. *Of the Smelting of Tin Ores.*

The tin-ores commonly smelted are those which consist of calx of tin combined with calx of arsenic and sometimes with calx of iron. These are either pure, as the tin-grains, or intermixed with spars, stones, pyrites, ores of copper, iron, or of other metals.

The impure ores must be cleaned as much as is possible from all heterogeneous matters. This cleaning is more necessary in ores of tin than of any other metal; because in the smelting of tin-ores a less intense heat must be given than is sufficient for the scorification of earthy matters, lest the tin be calcined. Tin-ores previously bruised may be cleaned by washing, for which operation their great weight and hardness render them well adapted. If they be intermixed with very hard stones or ferruginous ores, a slight roasting will render these impure matters more friable, and consequently fitter to be separated from the tin-ores. Sometimes these operations, the roasting, contusion, and lotion, must be repeated. By roasting, the ferruginous particles are so far revived, that they may be separated by magnets.

The ore, thus cleaned from adhering heterogeneous matters, is to be roasted in an oven or reverberatory furnace with a fire rather intense than long continued, during which it must be frequently stirred to prevent its fusion. By this operation, the arsenic is expelled, and in some works is collected in chambers built purposely above the calcining furnace.

Lastly, the ore cleaned and roasted is to be fused, and reduced to a metallic state. In this fusion, attention must be given to the following particulars. 1. No more heat is to be applied than is sufficient for the reduction of the ore; because this metal is fusible with very little heat, and is very easily calcinable. 2. To prevent this calcination of the reduced metal, a larger quantity of charcoal is used in this than in most other fusions. 3. The scoria must be frequently removed, lest some of the tin should be involved in it, and the melted metal must be covered with charcoal powder to prevent the calcination of its surface. 4. No flux or other substance, excepting the scoria of former smeltings which contains some tin, are to be added, to facilitate the fusion.

#### SECT. VIII. *Smelting of Ores of Lead.*

Ores of lead are either pure, that is, containing

Smelting  
of Tin ores. no mixture of other metal; or they are mixed with silver, copper, or pyrites. The methods of treating ores of lead containing silver and copper, are described in the sections of *Smelting of Ores of Silver and of Copper*; and in the former of these an instance is given of the method of smelting the ore of Rammelsberg, which contains all these three metals.

Pure ores of lead, and those which contain so small a quantity only of silver as not to compensate for the expence of extracting the nobler metal, may be smelted in furnaces, and by operations similar to those used at Rammelsberg, or in the following methods. 1. From the lead-ore of Willach in Carinthia, a great part of the lead is obtained by a kind of eliquation, during the roasting of the ore. For this purpose, the ore is thrown upon several strata or layers of wood, placed in a calcining or reverberatory furnace. By kindling this wood, a great part of the lead flows out of the ore, through the layers of fuel, into a basin placed for its reception. The ore which is thus roasted is beat into smaller pieces, and exposed to a second operation similar to the former, by which more metal is eliquated; and the remaining ore is afterwards ground, washed, and smelted, in the ordinary method.

The lead of Willach is the purest of any known. Schlutter ascribes its great purity to the method used in extracting it, by which the most fusible, and consequently the purest part of the contained lead is separated from any less fusible metal which happens to be mixed with it, and which remains in the roasted ore. This method requires a very large quantity of wood.

2. In England, lead ores are smelted either upon a hearth, or in a reverberatory furnace called a *cupel*.

In the first of these methods, charcoal is employed as fuel, and the fire is excited by bellows. Small quantities of fuel and of ore are thrown alternately and frequently upon the hearth. The fusion is very quickly effected; and the lead flows from the hearth as fast as it is separated from the ore.

3. In the second method practised in England, pit-coal is used as fuel. The ore is melted by means of the flame passing over its surface; its sulphur is burnt and dissipated, while the metal is separated from the scoria, and collected at the bottom of the furnace. When the ore is well cleaned and pure, no addition is requisite; but when it is mixed with calcareous or earthy matrix, a kind of fluor or fusible spar found in the mines is generally added to render the scoria more fluid, and thereby to assist the precipitation of the metal. When the fusion has been continued about eight hours, a passage in the side of the furnace is opened, through which the liquid lead flows into an iron cistern. But immediately before the lead is allowed to flow out of the furnace, the workmen throw upon the liquid mass a quantity of slacked quicklime, which renders the scoria so thick and tenacious, that it may be drawn out of the furnace by rakes. Schlutter mentions this addition of quicklime in the smelting of lead ores in England, but thinks that it is intended to facilitate the fusion of the ores; whereas it really has a contrary effect, and is never added till near the end of the operation, when the scoria is to be raked from the surface of the metal.

### SECT. IX. *Of the Smelting of Ores of Semi-metals.*

ANTIMONY is obtained by a kind of eliquation from the minerals containing it, as is described in the article ANTIMONY; and the regulus of antimony is procured from antimony, by the processes described in the same article, and in the article REGULUS OF ANTIMONY.

*Arsenic, saffre, and bismuth,* are obtained generally from one ore, namely, that called *cobalt*. The arsenic of the ore is separated by roasting, and adheres to the internal surface of a chimney, which is extended horizontally about 200 or 300 feet in length, and in the sides of which are several doors, by means of which the arsenic, when the operation is finished, may be swept out and collected. These chimneys are generally bent in a zig-zag direction, that they may better retard and stop the arsenical flowers. These flowers are of various colours, white, grey, red, yellow, according to the quantity of sulphur or other impurity, with which they happen to be mixed. They are afterwards purified by repeated sublimations; while some alkaline or other substances are added to detain the sulphur, and to assist the purification.

In the same roasting of the ore by which the arsenic is expelled, the bismuth, or at least the greatest part of this semi-metal which is contained in the ore, being very fusible, and having no disposition to unite with the regulus of cobalt, which remains in the ore, is separated by eliquation.

The remaining part of the roasted ore consists chiefly of calx of regulus of cobalt, which not being volatile, as the arsenic is, nor so easily fusible as bismuth is, has been neither volatilized nor melted. It contains also some bismuth, and a small quantity of arsenic, together with any silver or other fixed metal which happened to be contained in the ore. This roasted ore being reduced to a fine powder, and mixed with three or four times its weight of fine sand, is the powder called

*saffre* or *zaffre*. Or the roasted ore is sometimes fused with about thrice its quantity of pure sand and as much pure pot-ash, by which a blue glass, called *smalt*, is produced; and a metallic mass, called *speiss*, is collected at the bottom of the vessel in which the matters are fused. The metallic mass or *speiss* is composed of very different substances, according to the contents of the ore and the methods of treating it. The matters which it contains at different times are, nickel, regulus of cobalt, bismuth, arsenic, sulphur, copper, and silver.

Bismuth is seldom procured from any other ores but that of cobalt. It might, however, be extracted from its proper ores, if a sufficient quantity of these were found, by the same method by which it is obtained from cobalt, namely, by eliquation.

*Mercury*, when native, and enveloped in much earthy or other matter, from which it cannot be separated merely by washing, is distilled either by ascent or by descent. When it is mineralized by sulphur, that is, when it is contained in cinnabar, some intermediate substance, as quicklime, or iron, must be added in the distillation, to disengage it from the sulphur.

The rich ore of Almaden in Spain is a cinnabar, with which a calcareous stone happens to be so blend-

ed, that no addition is required to disengage the mercury from the sulphur. The distillation is there performed in a furnace consisting of two cavities, one of which is placed above another. The lower cavity is the fire-place, and contains the fuel, resting upon a grate, through the bars of which the air enters, maintaining the fire, and passes into a chimney, placed at one side of the fire-place immediately above the door thro' which fuel is to be introduced. The roof of this fire-place, which is vaulted and pierced with several holes, is also the floor of the upper cavity. Into this upper cavity, the mineral from which mercury is to be distilled is introduced, through a door in one of the sides of the furnace. In the opposite wall of this cavity are eight openings, all at the same height. To each of these openings is adapted a file of aludels connected and luted together, extending 60 feet in length. These aludels, which are earthen vessels open at each end, and wider in the middle than at either extremity,

are supported upon an inclined terras; and the aludel of each file, that is most distant from the furnace, terminates in a chamber built of bricks, which has two doors, and two chimneys.

When the upper cavity is filled sufficiently with the mineral, a fire is made below, which is continued during 12 or 14 hours. The heat is communicated thro' the holes of the vaulted roof of the fire-place to the mineral in the upper cavity, by which means the mercury is volatilized, and its vapour passes into the aludels, where much of it is condensed, and the rest is discharged into the brick-chamber, in which it circulates till it also is condensed. If any air or smoke passes through the aludels along with the vapour of the mercury, they escape thro' the two chimneys of the chamber. Three days after the operation, when the apparatus is sufficiently cooled, the aludels are unluted, the doors of the chamber are opened, and the mercury is collected.

## M E T

Metamor-  
phosis,  
Metaphor.

METAMORPHOSIS, in general, denotes the changing of something into a different form; in which sense it includes the transformation of insects, as well as the mythological changes related by the ancient poets.

Mythological metamorphoses were held to be of two kinds, apparent and real: thus, that of Jupiter into a bull, was only apparent; whereas that of Lycaon into a wolf, was supposed to be real.

Most of the ancient metamorphoses include some allegorical meaning, relating either to physics or morality: some authors are even of opinion that a great part of the ancient philology is couched under them; and Lord Bacon and Dr Hook have attempted to unriddle several of them.

METAPHOR, in rhetoric. See ORATORY, n° 50. METAPHOR and Allegory, in poetry.—A metaphor differs from a simile, in form only, not in substance: in a simile the two subjects are kept distinct in the expression, as well as in the thought; in a metaphor, the two subjects are kept distinct in the thought only, not in the expression. A hero resembles a lion, and upon that resemblance many similes have been raised by Homer and other poets. But instead of resembling a lion, let us take the aid of the imagination, and feign or figure the hero to be a lion: by that variation the simile is converted into a metaphor; which is carried on by describing all the qualities of a lion that resemble those of the hero. The fundamental pleasure here, that of resemblance, belongs to the thought. An additional pleasure arises from the expression: the poet, by figuring his hero to be a lion, goes on to describe the lion in appearance, but in reality the hero; and his description is peculiarly beautiful, by expressing the virtues and qualities of the hero in new terms, which, properly speaking, belong not to him, but to the lion. This will better be understood by examples. A family connected with a common parent, resembles a tree, the trunk and branches of which are connected with a common root: but let us suppose, that a family is figured, not barely to be like a tree, but to be a tree; and then the simile will be converted into a metaphor, in the following manner.

## M E T

Edward's sev'n sons, whereof thyself art one,  
Were sev'n fair branches, springing from one root;  
But some of these branches by the devil's cut:  
But Thomas, my dear lord, my life, my Glo'ster,  
One flourishing branch of his most royal root,  
Is hack'd down, and his summer-leaves all faded,  
By Envy's hand and Murder's bloody axe.

Richard II. act i. sc. 3.

Figuring human life to be a voyage at sea:

There is a tide in the affairs of men,  
Which, taken at the flood, leads one to Fortune:  
Omitted, all the voyage of their life  
Is bound in shallows and in miseries.  
On such a full sea are we now afloat;  
And we must take the current when it serves,  
Or lose our ventures. *Julius Cæsar, act iv. sc. 5.*

Figuring glory and honour to be a garland of flowers:

• *Hotspur.* ————— Wou'd to heaven's,  
Thy name in arms were now as great as mine!  
*Pr. Henry.* I'll make it greater, ere I part from thee;  
And all the budding honours on thy crest  
I'll crop, to make a garland for my head.

First part of Henry IV. act v. sc. 9.

Figuring a man who hath acquired great reputation and honour to be a tree full of fruit:

————— Oh, boys, this story  
The world may read in me: my body's mark'd  
With Roman swords; and my report was once  
First with the best of note. Cymbeline lov'd me;  
And when a soldier was the theme, my name  
Was not far off: then was I as a tree,  
Whose boughs did bend with fruit. But in one night,  
A storm or robbery, call it what you will,  
Shook down my mellow hangings, nay my leaves;  
And left me bare to weather.

Cymbeline, act iii. sc. 3.

“Blest be thy soul, thou king of shells, said Swaran  
of the dark-brown shield. In peace, thou art the gale  
of spring; in war, the mountain-storm. Take now my  
hand in friendship, thou noble king of Morven.”

Fingal.  
“Thou

Metaphor.

“Thou dwellest in the foul of Malvina, son of mighty Olfian. My sighs arise with the beam of the east: my tears descend with the drops of night. I was a lovely tree in thy presence, Olfar, with all my branches round me: but thy death came like a blast from the desert, and laid my green head low; the spring returned with its showers, but no leaf of mine arose.”

*Fingal.*

An allegory differs from a metaphor; and what lord Kaim's calls a *figure of speech* differs from both. A metaphor is defined above to be an act of the imagination, figuring one thing to be another. An allegory requires no such operation, nor is one thing figured to be another: it consists in choosing a subject having properties or circumstances resembling those of the principal subject; and the former is described in such a manner as to represent the latter: the subject thus represented is kept out of view: we are left to discover it by reflection; and we are pleased with the discovery, because it is our own work. (See the word ALLEGORY.)

Quintilian gives the following instance of an allegory,

O navis, referent in mare te novi  
Fluctus. O quid agis? fortiter occupa portum.

*Horat. lib. i. ode 14.*

and explains it elegantly in the following words: “Totiusque ille Horatii locus, quo navim pro republica, fluctum tempestates pro bellis civilibus, portum pro pace atque concordia, dicit.”

In a *figure of speech*, there is no fiction of the imagination employed, as in a metaphor; nor a representative subject introduced, as in an allegory. This figure, as its name implies, regards the expression only, not the thought; and it may be defined, the using a word in a sense different from what is proper to it. Thus youth, or the beginning of life, is expressed figuratively by *morning of life*: morning is the beginning of the day; and in that view it is employed to signify the beginning of any other series, life especially, the progress of which is reckoned by days. See *FIGURE of Speech*.

*Metaphor and allegory* are so much connected, that it seemed proper to handle them together: the rules, particularly for distinguishing the good from the bad, are common to both. We shall therefore proceed to these rules, after adding some examples to illustrate the nature of an *allegory*, which, with a view to this article, was but slightly illustrated under its proper name.

Horace, speaking of his love to Pyrrha, which was now extinguished, expresseth himself thus:

—Me tabulâ facer  
Votivâ paries indicat uvida  
Suspendisse potenti  
Vestimenta maris Deo. *Carm. lib. i. ode 5.*

Again:

Phæbus volentem prælia me loqui,  
Viciâs et urbes, increpuit lyrâ:  
Ne parva Tyrrenum pro æquor  
Vela darem. *Carm. lib. v. ode 15.*

*Queen.* Great Lords, wise men ne'er sit and wail their  
lofs,

But cheerly seek how to redress their harms.  
What though the mast be now blown overboard,  
The cable broke, the holding-anchor loft,  
Vol. VII.

Metaphor.

And half our failors swallowed in the flood?  
Yet lives our pilot still. Is't meet that he  
Should leave the helm, and, like a fearful lad,  
With tearful eyes add water to the sea,  
And give more strength to that which hath too much;  
While in his moan the ship splits on the rock,  
Which industry and courage might have sav'd?  
Ah, what a shame! ah, what a fault were this!

*Third part Henry VI. act v. sc. 5.*

*Oroonoko.* Ha! thou hast rous'd

The lion in his den; he stalks abroad,  
And the wide forest trembles at his roar.

I find the danger now. *Oroonoko, act iii. sc. 2.*

“My well-beloved hath a vineyard in a very fruitful hill. He fenced it, gathered out the stones thereof, planted it with the choicest vine, built a tower in the midst of it, and also made a wine-press therein; he looked that it should bring forth grapes, and it brought forth wild grapes. And now, O inhabitants of Jerusalem, and men of Judah, judge, I pray you, betwixt me and my vineyard. What could have been done more to my vineyard, that I have not done? Wherefore, when I looked that it should bring forth grapes, brought it forth wild grapes? And now go to, I will tell you what I will do to my vineyard: I will take away the hedge thereof, and it shall be eaten up; and break down the wall thereof, and it shall be trodden down. And I will lay it waste: it shall not be pruned, nor digged, but there shall come up briars and thorns: I will also command the clouds that they rain no rain upon it. For the vineyard of the Lord of hosts is the house of Israel, and the men of Judah his pleasant plant.”

*Isaiab. v. 1.*

The rules that govern metaphors and allegories are of two kinds. The construction of these figures comes under the first kind: the propriety or impropriety of introduction comes under the other.—To begin with rules of the first kind; some of which coincide with those already given for similes; some are peculiar to metaphors and allegories:

In the first place, it has been observed, that a simile cannot be agreeable where the resemblance is either too strong or too faint. This holds equally in metaphor and allegory; and the reason is the same in all. In the following instances, the resemblance is too faint to be agreeable.

*Malcolm.*——But there's no bottom, none,  
In my voluptuousness: your wives, your daughters,  
Your matrons, and your maids, could not fill up  
The cistern of my lust. *Macbeth, act iv. sc. iv.*

The best way to judge of this metaphor, is to convert it into a simile; which would be bad, because there is scarce any resemblance between lust and a cistern, or betwixt enormous lust and a large cistern.

Again:

He cannot buckle his distemper'd cause  
Within the belt of rule. *Macbeth, act v. sc. 2.*

There is no resemblance between a distemper'd cause and any body that can be confined within a belt.

Again:

Steep me in poverty to the very lips.  
*Othello, act iv. sc. 9.*

Poverty here must be conceived a fluid, which it resembles not in any manner.

Metaphor. Speaking to Bolingbroke banish'd for six years:

The fullen passage of thy weary steps  
Ereem a foil, wherein thou art to fet  
The precious jewel of thy home-return.

*Richard II. act ii. sc. 6.*

Again:

Here is a letter, lady,  
And every word in it a gaping wound  
Issuing life-blood.

*Merchant of Venice, Act iii. sc. 3.*

Tantæ molis erat Romanam condere gentem.

*Æneid. i. 37.*

The following metaphor is strained beyond all endurance: Timur-bec, known to us by the name of *Tamerlane the Great*, writes to Bajazet emperor of the Ottomans in the following terms:

“Where is the monarch who dares resist us? where is the potentate who doth not glory in being numbered among our attendants? As for thee, descended from a Turcoman sailor, since the vessel of thy unbounded ambition hath been wreck'd in the gulf of thy self-love, it would be proper, that thou shouldst take in the sails of thy temerity, and cast the anchor of repentance in the port of sincerity and justice, which is the port of safety; lest the tempest of our vengeance make thee perish in the sea of the punishment thou deservest.”

Such strained figures, as observed above, are not uncommon in the first dawn of refinement: the mind in a new enjoyment knows no bounds, and is generally carried to excess, till taste and experience discover the proper limits.

Secondly, Whatever resemblance subjects may have, it is wrong to put one for another, where they bear no mutual proportion. Upon comparing a very high to a very low subject, the simile takes on an air of burlesque: and the same will be the effect, where the one is imagined to be the other, as in a metaphor; or made to represent the other, as in an allegory.

Thirdly, These figures, a metaphor especially, ought not to be crowded with many minute circumstances; for in that case it is scarcely possible to avoid obscurity. A metaphor above all ought to be short: it is difficult, for any time, to support a lively image of a thing being what we know it is not; and for that reason, a metaphor drawn out to any length, instead of illustrating or enlivening the principal subject, becomes disagreeable by overstraining the mind. Here Cowley is extremely licentious: take the following instance.

Great and wise conqueror, who, where'er  
Thou com'st, dost fortify, and settle there!  
Who canst defend as well as get;

And never hadst one quarter beat up yet;

Now thou art in, thou ne'er will part

With one inch of my vanquish'd heart;

For since thou tookst it by assault from me,

'Tis garrison'd so strong with thoughts of thee

It fears no beauteous enemy.

For the same reason, however agreeable long allegories may at first be by their novelty, they never afford any lasting pleasure: witness the *Fairy Queen*, which with great power of expression, variety of images, and melody of versification, is scarce ever read a second time.

In the fourth place, the comparison carried on in a

simile, being in a metaphor sunk by imagining the metaphor principal subject to be that very thing which it only resembles; an opportunity is furnished to describe it in terms taken strictly or literally with respect to its imagined nature. This suggests another rule. That in constructing a metaphor, the writer ought to make use of such words only as are applicable literally to the imagined nature of his subject: figurative words ought carefully to be avoided; for such complicated figures, instead of setting the principal subject in a strong light, involve it in a cloud; and it is well if the reader, without rejecting by the lump, endeavour patiently to gather the plain meaning, regardless of the figures:

A stubborn and unconquerable flame

Creeps in his veins, and drinks the streams of life.

*Lady Jane Gray, act i. sc. 1.*

Copied from Ovid,

Sorbent avidæ præcordia flammæ.

*Metamorph. lib. ix. 172.*

Let us analyse this expression. That a fever may be imagined a flame, we admit; though more than one step is necessary to come at the resemblance: a fever, by heating the body, resembles fire; and it is no stretch to imagine a fever to be a fire: again, by a figure of speech, flame may be put for fire, because they are commonly conjoined; and therefore a fever may be termed a flame. But now, admitting a fever to be a flame, its effects ought to be explained in words that agree literally to a flame. This rule is not observed here; for a flame drinks figuratively only, not properly.

King Henry to his son prince Henry:

Thou hid'st a thousand daggers in thy thoughts,

Which thou hast whetted on thy stony heart

To stab at half an hour of my frail life.

*Second part Henry IV. act iv. sc. 11.*

Such faulty metaphors are pleasantly ridiculed in the *Rehearsal*:

“Physician. Sir, to conclude, the place you fill has more than amply exacted the talents of a wary pilot; and all these threatening storms, which, like impregnate clouds, hover o'er our heads, will, when they once are grasp'd but by the eye of reason, melt into fruitful showers of blessings on the people.

“Bayer. Pray mark that allegory. Is not that good?

“Johnson. Yes, that grasping of a form with the eye is admirable.”

*Act ii. sc. 1.*

Fifthly, The jumbling different metaphors in the same sentence, beginning with one metaphor and ending with another, commonly called a *mist metaphor*, ought never to be indulged.

*K. Henry.*—Will you again knit

This churlish knot of all-aborred war,

And move in that obedient orb again,

Where you did give a fair and natural light?

*First part Henry VI. act v. sc. 1.*

Whether 'tis nobler in the mind, to suffer

The stings and arrows of outrageous fortune;

Or to take arms against a sea of troubles,

And by opposing end them.

*Hamlet, act iii. sc. 2.*

In the sixth place, It is unpleasant to join different metaphors in the same period, even where they are preserved



*Metaphor.* preserved distinct: for when the subject is imagined to be first one thing and then another in the same period without interval, the mind is distracted by the rapid transition; and when the imagination is put on such hard duty, its images are too faint to produce any good effect:

At regina gravi jamdudum faucibus cura,  
Vulnus alit venis, et caeco carpitur igni.

*Æneid. iv. 1.*

— — — — — Est mollis flamma medullas  
Interea, et tacitum vivit sub pectore vulnus.

*Æneid. iv. 66.*

Motum ex Metello consulē cívicos,  
Bellique causas, et vitia, et modicos,  
Ludumque fortunæ, gravæque  
Principum amicitias, et arma  
Nondum expiatis unctâ cruoribus,  
Periculose plenum opus alicæ,  
Tractas, et incedis per ignes  
Subpositos cineri doloso.

*Horat. Carm. lib. ii. ode 1.*

In the last place, It is still worse to jumble together metaphorical and natural expression, so as that the period must be understood in part metaphorically in part literally; for the imagination cannot follow with sufficient ease changes so sudden and unprepared: a metaphor begun and not carried on, hath no beauty; and instead of light, there is nothing but obscurity and confusion. Influences of such incorrect composition are without number: we shall, for a specimen, select a few from different authors.

Speaking of Britain.

This precious stone set in the sea,  
Which serves it in the office of a wall,  
Or as a moat defensive to a house  
Against the envy of less happier lands.

*Richard II. act ii. sc. 1.*

In the first line Britain is figured to be a precious stone: in the following lines, Britain, divested of her metaphorical dress, is presented to the reader in her natural appearance.

These growing feathers pluck'd from Cæsar's wing,  
Will make him fly an ordinary pitch,  
Who else would soar above the view of men,  
And keep us all in servile fearfulness.

*Julius Cæsar, act i. sc. 1.*

Rebus angustis animosus atque  
Fortis adpare: sapienter idem  
Contrahe vento nimium secundo  
Turgida vela.

*Hor.*

The following is a miserable jumble of expressions, arising from an unsteady view of the subject, between its figurative and natural appearance:

But now from gathering clouds destruction pours,  
Which ruins with mad rage our halcyon hours:  
Mists from black jealousies the tempest form,  
Whilst late divisions reinforce the storm.

*Dispensary, canto iii.*

To thee the world its present homage pays,  
The harvest early, but mature the praise.

*Pope's imitation of Horace, B. ii.*

Oui, sa pudeur n'est que franche grimace,  
Qu'une ombre de vertu qui garde mal la place,

Et qui s'évanouit, comme l'on peut favoir,  
Aux rayons du soleil qu'une bourse fait voir.

*Molière, L'Étourdi, act iii. sc. 2.*

Et son feu, depourvu de sensé et de lecture,  
S'éteint à chaque pas, faut de nourriture.

*Boileau, L'art poétique, chant. iii. l. 319.*

Dryden, in his dedication of the translation of *Juvenal*, says, "When thus, as I may say, before the use of the loadstone, or knowledge of the compass, I was sailing in a vast ocean, without other help than the pole-star of the ancients, and the rules of the French usage among the moderns, &c."

"There is a time when factions, by the vehemence of their own fermentation, stun and disable one another."

*Bolingbroke.*

This fault of jumbling the figure and plain expression into one confused mass, is not less common in allegory than in metaphor. Take the following examples.

— — — — — Heu! quoties fidem,  
Mutatosque Deos flebit, et aspera

*Nigris æquora ventis*

*Emirabitur insolens,*

*Qui nunc te fruitur credulus aureâ:*

*Qui semper vacuam, semper amabilem*

*Sperat, nescius aureæ*

*Fallacis.*

*Horat. Carm. lib. i. ode 5.*

Pour moi fur cette mer, qu'ici bas nous courons,  
Je songe à me pourvoir d'esquif et d'avirons,  
A régler mes desirs, à prévenir l'orage,  
Et sauver, s'il se peut, ma Raïson du naufrage.

*Boileau, épître 5.*

Lord Halifax, speaking of the ancient fabulists: "They (says he) wrote in signs, and spoke in parables: all their fables carry a double meaning: the story is one, and entire; the characters the same throughout; not broken or changed, and always conformable to the nature of the creature they introduce. They never tell you, that the dog which snapp'd at a shadow, lost his troop of horse; that would be unintelligible. This is his (Dryden's) new way of telling a story, and confounding the moral and the fable together." After instancing from the hind and panther, he goes on thus: "What relation has the hind to our Saviour? or what notion have we of a panther's Bible? If you say he means the church, how does the church feed on lawns, or range in the forest? Let it be always a church, or always a cloven-footed beast; for we cannot bear his shifting the scene every line."

A few words more upon allegory. Nothing gives greater pleasure than this figure, when the representative subject bears a strong analogy, in all its circumstances, to that which is represented: but the choice is seldom so lucky; the analogy being generally so faint and obscure, as to puzzle and not please. An allegory is still more difficult in painting than in poetry: the former can show no resemblance but what appears to the eye; the latter hath many other resources for showing the resemblance. And therefore, with respect to what the Abbé du Bos terms *mixt allegorical compositions*, these may do in poetry; because, in writing, the allegory can easily be distinguished from the historical part: no person, for example, mistakes Virgil's Fame

for

*Metaphor.* for a real being. But such a mixture in a picture is intolerable; because in a picture the objects must appear all of the same kind, wholly real or wholly emblematical. For this reason, the history of Mary de Medicis, in the palace of Luxembourg, painted by Rubens, is unpleasant by a perpetual jumble of real and allegorical personages, which produce a discordance of parts, and an obscurity upon the whole: witness, in particular, the tablature representing the arrival of Mary de Medicis at Marseilles; where, together with the real personages, the Nereids and Tritons appear founding their shells: such a mixture of fiction and reality in the same group, is strangely absurd. The picture of Alexander and Roxana, described by Lucian, is gay and fanciful; but it suffers by the allegorical figures. It is not in the wit of man to invent an allegorical representation deviating farther from any shadow of resemblance, than one exhibited by Lewis XIV. anno 1664; in which an enormous chariot, intended to represent that of the sun, is dragged along, surrounded with men and women, representing the four ages of the world, the celestial signs, the seasons, the hours, &c.; a monstrous composition, and yet scarce more absurd than Guido's tablature of Aurora.

In an allegory, as well as in a metaphor, terms ought to be chosen that properly and literally are applicable to the representative subject: nor ought any circumstance to be added that is not proper to the representative subject, however justly it may be applicable properly or figuratively to the principal. The following allegory is therefore faulty.

Ferus et Cupido,  
Semper ardentis acuens sagittas  
Cote crudelis.

*Horat. lib. ii. ode 8.*

For though blood may suggest the cruelty of love, it is an improper or immaterial circumstance in the representative subject: water, not blood, is proper for a whetstone.

We proceed to the next head, which is, to examine in what circumstances these figures are proper, in what improper. This inquiry is not altogether superseded by what is said upon the same subject in the article *COMPARISON*; because, upon trial, it will be found, that a short metaphor or allegory may be proper, where a simile, drawn out to a greater length and in its nature more solemn, would scarce be relished.

And, in the first place, a metaphor, like a simile, is excluded from common conversation, and from the description of ordinary incidents.

Second, in expressing any severe passion that totally occupies the mind, metaphor is unnatural.

The following example, of deep despair, beside the highly figurative style, hath more the air of raving than of sense:

*Calista.* Is it the voice of thunder, or my father?  
Madness! Confusion! let the storm come on,  
Let the tumultuous roar drive all upon me,  
Dash my devoted bark; ye surges, break it;  
'Tis for my ruin that the tempest rife.  
When I am lost, sunk to the bottom low,  
Peace shall return, and all be calm again.

*Fair Penitent, act 4.*

The following metaphor is sweet and lively; but

it suits not the fiery temper of Chamont, inflamed with passion; paraboles are not the language of wrath venting itself without restraint:

*Chamont.* You took her up a little tender flower,  
Just sprouted on a bank, which the next frost  
Had nipp'd; and with a careful loving hand,  
Tranplanted her into your own fair garden,  
Where the sun always shines: there long the flourish'd,  
Crew sweet to sense, and lovely to the eye;  
Till at the last a cruel spoiler came,  
Crop'd this fair rose, and rifed all its sweetness,  
Than cast it like a loathsome weed away.

*Orphan, act 4.*

The following speech, full of imagery, is not natural in grief and dejection of mind.

*Gonzalez.* O my son! from the blind dotage  
Of a father's fondness these ills arose.  
For thee I've been ambitious, base and bloody:  
For thee I've plung'd into this sea of sin;  
Stemming the tide with only one weak hand,  
While t'other bore the crown, (to wreathe thy brow),  
Whose weight has sunk me ere I reach'd the shore.

*Mourning Bride, act 5. sc. 6.*

There is an enchanting picture of deep distress in Macbeth, where Macduff is represented lamenting his wife and children, inhumanly murdered by the tyrant. Stung to the heart with the news, he questions the messenger over and over: not that he doubted the fact, but that his heart revolted against so cruel a misfortune. After struggling some time with his grief, he turns from his wife and children to their savage butcher; and then gives vent to his resentment, but still with manliness and dignity:

O, I could play the woman with mine eyes,  
And braggart with my tongue. But, gentle Heaven!  
Cut short all intermission; front to front  
Bring thou this fiend of Scotland and myself;  
Within my sword's length set him.—If he 'scape,  
Then Heaven forgive him too.

Metaphorical expression, indeed, may sometimes be used with grace where a regular simile would be intolerable: but there are situations so severe and dispiriting, as not to admit even the slightest metaphor. It requires great delicacy of taste to determine with firmness, whether the present case be of that nature: perhaps it is; yet who could wish a single word of this admirable scene altered?

But metaphorical language is proper when a man struggles to bear with dignity or decency a misfortune however great; the struggle agitates and animates the mind:

*Wolfey.* Farewell, a long farewell, to all my greatness!  
This is the state of man; to-day he puts forth  
The tender leaves of hope; to-morrow blossoms,  
And bears his blushing honours thick upon him;  
The third day comes a frost, a killing frost,  
And when he thinks, good easy man, full surely  
His greatness is a ripening, nips his root,  
And then he falls as I do.

*Henry VIII. act 3. sc. 6.*

*METAPHRASE,* a translator, or person who renders an author into another form or another language, word for word.

*METAPHYSICS.*

## M E T A P H Y S I C S.

**M**ETAPHYSICS is that part of philosophy which considers the nature and properties of thinking beings.

Aristotle, after treating on physics, begins his next book, (in which he pretends to elevate the mind above corporeal objects, to fix it on the contemplation of God, of angels, and of things spiritual, and to enable it to judge of the principles of sciences by abstraction,) with the Greek words *ΜΕΤΕ ΤΗ ΦΥΣΙΚΗ, post physicam*, i. e. *after physics*. His disciples, and succeeding philosophers, have formed, of these two, one word, **METAPHYSICS**, by which they mean that science of which we have just now given the definition.

Metaphysics is divided, according to the objects that it considers, into six principal parts, which are called, 1. *Ontology*. 2. *Cosmology*. 3. *Anthropology*. 4. *Psychology*. 5. *Pneumatology*: and, 6. *Theodicy*, or *metaphysical theology*.

1. The doctrine that is named *ontology*, is that part of metaphysics which investigates, and explains, the nature and general essence of all beings, as well as the qualities and attributes that essentially appertain to them, and which we ought to assign them by abstraction, as considering them *à priori*. Hence it appears, that this doctrine should proceed in its operations from the most simple ideas; such as do not admit of any other qualities of which they may be compounded. These simple ideas are, for example, those of being, of essence, of substance, of mode, of existence as well with regard to time as place, of a necessary cause, of unity, the idea of negation, the difference between a being that is simple or compound, necessary or accidental, finite or infinite; the idea of essential and abstract properties, as of the greatness, perfection, and goodness of beings; and so of the rest. The business therefore of ontology, is to make us acquainted with every kind of being in its essence and abstract qualities, and such as are distinct from all other beings. This knowledge being once established on simple principles, just consequences may from thence be drawn, and those things proved after which metaphysics inquires, and which is its business to prove.

It is easy to conceive, that even a clear knowledge of beings, and their essential properties, would be still defective and useless to man, if he did not know how to determine and fix his ideas by proper denominations, and consequently to communicate his perceptions to those whom he would instruct, or against whom he is obliged to dispute, as they would not have the same perceptions that he has. It is, by the way, perhaps, one of the greatest advantages that we have over other animals, to be able so to determine our ideas by signs or denominations, either of writing or speech, as to refer each particular perception to its general idea, and each general perception to its particular idea. To render therefore our ideas intelligible to others, we must have determinate words or denominations for each being, and the qualities of each being; and ontology teaches us those terms which are so necessary to fix our ideas, and to give them the requisite perspicuity and precision, that we

may not dispute about words when we endeavour to extend the sphere of our knowledge, or when we debate concerning the essence of an object, or endeavour to make it more evident. It is for this reason that ontology was formerly regarded as a barren science, that consisted of technical terms only; as a mere terminology: whereas the best modern philosophers make it a more substantial science, by annexing determinate ideas to those words, and the examination of those objects themselves that these terms imply. But the misfortune is, to speak the truth, that in this ontologic determination there is still much uncertainty and sophistry. For, in the first place, we yet know of no metaphysics where all the definitions are just; and in the second place, the words that are employed in these definitions have always something equivocal in their meaning, and have consequently themselves need of definitions; and in this manner we may recede to infinity, unless we recur to the first impressions that the simple words have made in our minds, and the primitive ideas which they there excite. The words *man, love, coach, &c.* say more, and make a stronger impression, than all the definitions we can give of them; by ontologic explications they are almost always covered with a dark cloud.

2. *Metaphysics*, after having, in as solid a manner as possible, explained and established the principles above-mentioned, continues its inquiries to the second part, that is called *Cosmology*, and examines into the essence of the world, and all that it contains; its eternal laws; of the nature of matter; of motion; of the nature of tangible bodies, of their attributes and essential qualities, and of all that can be known by abstraction, and sometimes also by adding the lights that man acquires concerning them by the experience of his senses. It is also in cosmology that we examine the Leibnitzian system; that is, whether God in creating the world must necessarily have created the best world; and if this world be so in effect. And in this manner they pursue the argument from consequence to consequence to its last resort. All philosophers, however, do not go equally deep. Each mind has its dose of penetration. Due care should be likewise taken, that subtilty, in this chain of reasoning, carried beyond the general bounds of the human mind, do not prejudice either the perspicuity or the truth of ideas: seeing that error here too nearly approaches the truth; and that every idea, which cannot be rendered intelligible, is in effect equal to a false idea.

3. *Anthropology*, or the knowledge of man, forms the third branch of metaphysics. It is subdivided into two parts. The first, which consists in the knowledge of the exterior parts of the human frame, does not belong to this science: anatomy and physiology teach that. The business here is only a metaphysical examination of man, his existence, his essence, his essential qualities and necessary attributes, all considered *à priori*: and this examen leads at the same time to

4. *Psychology*, which consists in the knowledge of the soul in general, and of the soul of man in particu-

lar; concerning which the most profound, the most subtle and abstract researches have been made, that the human reason is capable of producing; and concerning the substance of which, in spite of all these efforts, it is yet extremely difficult to assert any thing that is rational, and still less any thing that is positive and well supported.

5. The fifth part of metaphysics is called *pneumatology*. It is not a very long time since this term has been invented, and that metaphysicians have made of it a distinct doctrine. By this they mean the knowledge of all spirits, angels, &c. It is easy to conceive that infinite art is necessary to give an account of what we do not absolutely know any thing, and of which, by the nature of the subject itself, we never can know any thing. But the metaphysician presently offers to show us, " what is the idea of a spirit; the effective existence of a spirit; what are its general qualities and properties; that there are rational spirits, and that these rational spirits have qualities that are founded in the moral qualities of God:" for this is, in so many words, what is taught us by pneumatology.

6. *Metaphysical Theology*, which Mr. Leibnitz and some others call *Theodicy*, is the sixth and last doctrine of metaphysics. It teaches us the knowledge of the existence of God; to make the most rational suppositions concerning his divine essence, and to form a just idea of his qualities and perfections, and to demonstrate them by abstract reasoning *à priori*. Theodicy differs from natural theology, in as much as this last borrows, in fact, from theodicy proofs and demonstrations to confirm the existence of a Supreme Being; but after having solidly established that great truth, by extending its consequences, natural theology teaches us what are the relations and connexions that subsist between that Supreme Being and man, and what are the moral duties that result from that connexion. As pneumatology is a science highly insidious and chimerical, so is metaphysical theology susceptible of sound argument and demonstration; to the great comfort of mankind, the whole of whose happiness is founded on the certainty of this science. If the effects and operations of spirits in the universe were as evident as the effects and operations of the Deity, and their necessary existence as capable of being proved *à priori*, pneumatology would be a doctrine of equal certainty with theodicy: but as neither one nor the other can be proved with regard to spirits in general, whilst God manifests himself in every part of nature, we have only to descend from the most simple and abstract ideas, to those that are the most compound; and from thence to ascend, by a chain of reasonings, from the creature up to the Author of the creature and of all nature: we shall find, that the result of all these operations of the mind will constantly be, The necessity of the existence of a God; and we may at all times determine, tho' very imperfectly, from the weakness of our discernment, what that Supreme Being must be, by positively determining what he cannot be. Every thing that can concur to furnish new proofs on this subject, or to elucidate and establish those which are already known, is therefore of inestimable value to mankind; and though this were the only object of metaphysics, it would highly merit the attention of those of the most refined and most exalted genius.

After giving this general view of the subject, we shall proceed to give the substance of what Mr. Locke has delivered upon it.

SECT. I. Of Ideas in general, and their Original.

7. By the term *idea*, as defined by Mr. Locke, is meant whatever is the object of the understanding when a man thinks, or whatever it is which the mind can be employed about in thinking.

8. In order to trace the manner by which we acquire these ideas, let us suppose the mind to be, as we say, *white paper*, void of all characters, without any *ideas*: how comes it to be furnished? whence has it all the materials of reason and knowledge? From *experience* and *observation*. This, when employed about external sensible objects, we may call *sensation*: by this we have the ideas of *bitter, sweet, yellow, hard, &c.* which are commonly called *sensible qualities*, because conveyed into the mind by the senses. The same experience, when employed about the internal operations of the mind, perceived and reflected on by us, we may call *reflection*: hence we have the *ideas* of *perception, thinking, doubting, willing, reasoning, &c.*

9. These two, viz. *external material things* as the objects of sensation, and the *operations of our own minds* as the objects of reflection, are the only *originals* from whence all our *ideas* take their beginnings: the understanding seems not to have the least glimmering of *ideas* which it doth not receive from one of these two sources. These, when we have taken a full survey of them, and their several *modes* and compositions, we shall find to contain our whole stock of *ideas*: and that we have nothing in our minds which did not come in one of these two ways.

10. It is evident, that children come by degrees to be furnished with *ideas* from the objects they are conversant with: they are so surrounded with bodies that perpetually and diversely affect them, that some ideas will (whether they will or no) be imprinted on their minds. *Light and colours, sounds and tangible qualities*, do continually sollicit their proper senses, and force an entrance into the mind. It is late, commonly, before children come to have *ideas* of the operations of their minds; and some men have not any very clear or perfect *ideas* of the greatest part of them all their lives: because, tho' they pass there continually, yet, like floating visions, they make not deep impressions enough to leave in the mind clear and lasting *ideas*, till the understanding turns inward upon itself, and reflects on its own operation, and makes them the objects of its own contemplation.

11. When a man first perceives, then he may be said to have *ideas*; having ideas, and perception, signifying the same thing.

## SECT. II. Of Simple Ideas.

Of ideas, some are *simple*, others *complex*. A *simple idea* is one uniform appearance or conception in the mind, which is not distinguishable into different *ideas*. Such are the *ideas* of *sensible qualities*, which though they are in the things themselves so united and blended, that there is no separation, no distance between them, yet the *ideas* they produce in the mind enter by the senses simple and unmixed. Thus, tho' the

Different sorts of Ideas.

the hand feels *softness*; and *warmth* in the same piece of wax, yet the *simple ideas* thus united in the same subject are as perfectly *distinct* as those that come in by different senses.

12. These *simple ideas* are suggested no other way than from the two ways above-mentioned, viz. *sensation* and *reflection*.

13. The mind being once stored with the *simple ideas*, has the power to repeat, compare, and unite them to an infinite variety; and so can make, at pleasure, new *complex ideas*. But the most enlarged understanding cannot frame one new *simple idea*; nor by any force destroy them that are there.

14. Ideas, with reference to the different ways wherein they approach the mind, are of *four sorts*.

First, There are some which come into our minds by *one sense only*.

Secondly, There are others conveyed into the mind by *more senses than one*.

Thirdly, Others that are had from *reflection only*.

Fourthly, There are some suggested to the mind by all the ways of *sensation* and *reflection*.

### SECT. III. Of Ideas of one Sense.

15. SOME ideas enter into the mind only by one sense peculiarly adapted to receive them. Thus colours, sounds, smells, &c. come in only by the eyes, ears, and nose. And if these organs are any of them so disordered as not to perform their functions, they have no other way to bring themselves in view, and be perceived by the understanding.

16. We shall here mention one, which we receive by our touch, because it is one of the chief ingredients in many of our complex ideas; and that is, the idea of *solidity*: it arises from the resistance one body makes to the entrance of another body into the place it possesses, till it has left it. There is no idea which we more constantly receive from sensation than this. In whatever posture we are, we feel somewhat that supports us, and hinders us from sinking downwards: and the bodies we daily handle, make us perceive, that while they remain between them, they do, by an unsurmountable force, hinder the approach of the parts of our hands that press them. This seems to be the most essential property of body, and that whereby we conceive it to fill space: the idea of which is, that where we imagine any space taken up by a solid substance, we conceive it so to possess it, that it excludes all other solid substances. This resistance is so great, that no force can surmount it. All the bodies in the world pressing a drop of water on all sides, will never be able to overcome the resistance it makes to their approaching one another, till it be removed out of their way.

17. The idea of *solidity* is distinguished from that of *pure space*, in as much as this latter is neither capable of resistance nor motion: it is distinguished from *hardness*, in as much as hardness is a firm cohesion of the solid parts of matter making up masses of a sensible bulk, so that the whole does not easily change its figure. Indeed, *hard* and *soft*, as commonly apprehended by us, are but *relative* to the constitutions of our bodies: that being called *hard* which will put us to pain sooner than change its figure by the pressure of any part of our bodies; and that *soft*, which

changes the situation of its parts upon an easy and un painful touch.

18. This difficulty of changing situation among the parts, gives no more solidity to the hardest body than to the softest; nor is an adamant one jot more solid than water. He that shall fill a yielding soft body well with air or water, will quickly find its resistance. By this we may distinguish the idea of the extension of body, from the idea of the extension of space: That of body, is the cohesion or continuity of solid, separable, and moveable parts; that of space, the continuity of un-solid, inseparable, and immovable parts. Upon the solidity of bodies depend their: mutual impulse, resistance, and protrusion.

### SECT. IV. Of Simple Ideas of different Senses.

19. SOME ideas we get into the mind by *more than one sense*; as *space*, *extension*, *figure*, *rest*, and *motion*. These are perceivable by the eyes and touch.

### SECT. V. Of Simple Ideas of Reflection.

20. SOME ideas are had from reflection only. Such are the ideas we have of the operations of our minds: of which the two principal are, *perception*, or *thinking*; and *volition*, or *willing*. The powers of producing these operations are called *faculties*; which are, the *understanding*, and *will*. The several *modes* of thinking, &c. belong to this head.

### SECT. VI. Of Simple Ideas of Sensation and Reflection.

21. THERE are some simple ideas conveyed into the mind by all the ways of *sensation* and *reflection*; such are *pleasure*, *pain*, *power*, *existence*, *unity*, *succession*. Pleasure or delight, pain or uneasiness, accompany almost every impression on our senses, and every action or thought of the *mind*.

22. The Author of our beings having given a power to our minds, in several instances, to choose amongst its ideas which it will think on; to excite us to these actions of *thinking* and *motion*, he has joined to several thoughts and sensations a perception of delight; without this we should have no reason to prefer one thought or action to another.

23. *Pain* has the same efficacy to set us on work that pleasure has; since we are as ready to avoid that, as to pursue this. This is worth our consideration, that *pain is often produced by the same objects and ideas that produce pleasure* in us. This their near conjunction gives us new occasion of admiring the wisdom and goodness of our *Maker*; who, designing the preservation of our being, has annexed pain to the application of many things to our bodies, to warn us of the harm they will do us, and as advices to withdraw us from them. But he not designing our preservation barely, but the preservation of every part and organ in its perfection, hath in many cases annexed pain to those very ideas which delight us. Thus heat, that is very agreeable to us in one degree, by a little greater increase of it proves no ordinary torment: Which is wisely ordered by *nature*, that when any object does by the vehemence of its operation disorder the instruments of sensation, whose structures cannot but be very delicate, we might by the pain be warned to withdraw before the organ be quite put out of order. That this is the *end of pain*, appears from this con-

Sensation and Reflection.

deration; that though great light is insufferable to the eyes, yet the highest degree of darkness does not at all diseafe them, because *that* causes no disorderly motion in that curious organ the eye. But equals of cold, as well as heat, pains us; because it is equally destructive to the temper which is necessary to the preservation of life.

24. *Existence and unity* are two other ideas suggested by every object without, and every idea within. When ideas are in our minds, we consider them as being actually there, as well as we consider things to be actually without us; which is, that they *exist*, or have existence: And whatever we consider as *one thing*, whether a *real being*, or *idea*, suggests the idea of *unity*.

25. *Power* is another idea derived from these fources: For finding in ourselves that we can *think*, and *move* several parts of our bodies at pleasure, and observing the *effects* that natural bodies produce in one another; by both these ways we get the idea of *power*.

26. *Succession* is another idea suggested by our senses, and by reflection on what passes in our minds: For if we look into ourselves, we shall find our *ideas* always, whilst we are awake, or have any thought, passing in train, one going and another coming, without intermission.

#### SECT. VII. *Some farther Considerations concerning Simple Ideas.*

27. WHATSOEVER is able, by affecting our senses, to cause any perception in the mind, doth hereby produce in the understanding a *simple idea*; which, whatsoever be the cause of it, is looked upon as a *real positive idea* in the understanding. Thus the ideas of *heat and cold*, *light and darkness*, *motion and rest*, &c. are equally positive in the mind, though some of their causes may be mere *privations*.

28. That a *privative* cause may produce a *positive* idea, appears from shadows; which, though nothing but the absence of light, are discernible, and cause clear and positive ideas. We have indeed some *negative* names which stand not directly for positive ideas, but of their absence; such as *insipid*, *silence*, which denote positive ideas, viz. *taste* and *sound*, with a signification of their absence.

29. It will be useful to distinguish *ideas* as they are *perceptions* in our minds, from what they are in the bodies that cause such perceptions in us; for we are not to think the former exact images and resemblances of something inherent in the subject, most of those of *fenation* being, in the mind, no more the likenesses of something existing without us, than the names that stand for them are the likenesses of our ideas, which yet, upon hearing, they excite in us.

30. Whatsoever the *mind perceives in itself*, or is the immediate object of perception, thought, or understanding, is an idea: And the power to produce any idea in our mind, is the *quality of the subject* wherein that power exists. Thus a *snow-ball* having the power to produce in us the ideas of *whiteness*, *cold*, and *round*; those *powers*, as they are in the snow-ball, are called *qualities*; and as they are *fenations* or *perceptions* in our understandings, they are called *ideas*. These *qualities* are of two sorts:

31. First, *Original*, or primary; such are *solidity*, *Perception*, *extension*, *motion*, or *rest*, *number*, and *figure*. These are inseparable from body, and such as it constantly keeps in all its changes and alterations.

32. Secondly, *Secondary qualities*; such as *colour*, *smells*, *tastes*, *sounds*, &c. which, whatever reality we by mistake may attribute to them, are in truth nothing in the objects themselves, but *powers* to produce various fenations in us; and depend on the qualities beforementioned.

33. The *ideas of primary* qualities of bodies, are resemblances of them; and their patterns really exist in bodies themselves: But the ideas produced in us by secondary qualities have no resemblance of them at all; and what is *sweet*, *blue*, or *warm*, in the idea, is but the certain bulk, figure, and motion of the sensible parts in the bodies themselves, which we call so.

34. Thus we see, that fire at one distance produces in us the fenation of *warmth*, which at a nearer approach causes the fenation of *pain*. Now what reason have we to say, that the idea of *warmth* is actually in the fire, but that of *pain* not in the fire, which the same fire produces in us the same way? The bulk, number, figure, and motion of the parts of fire, are really in it, whether we perceive them or not; and therefore may be called *real qualities*, because they really exist in that body: But *light* and *heat* are no more really in it, than sickness or pain: Take away the fenation of them; let not the eyes see light or colours, nor the ear hear sounds; let the palate not taste, or the nose smell; and all *colours*, *tastes*, *odours*, and *sounds*, as they are such particular ideas, vanish and cease, and are reduced to their causes, that is, bulk, motion, figure, &c. of parts.

35. These *secondary* qualities are of two sorts. First, *Immediately perceivable*: which by immediately operating on our bodies, produce several different ideas in us. Secondly, *Mediately perceivable*; which, by operating on other bodies, change their primary qualities, so as to render them capable of producing ideas in us different from what they did before. These last are powers in bodies, which proceed from the particular constitution of those primary and original qualities, to make such a change in the *bulk*, *figure*, *texture*, &c. of another body, as to make it operate on our senses different from what it did before; as in fire, to make lead fluid. These two last being nothing but powers relating to other bodies, and resulting from the different modifications of the original qualities, are yet otherwise thought of; the former being esteemed *real qualities*, but the latter barely *powers*.

#### SECT. VIII. *Of Perception.*

36. PERCEPTION is the first idea we receive from reflection. It is by some called *thinking* in general: Though *thinking*, in the propriety of the *English* tongue, signifies that sort of operation of the mind about its ideas, wherein the mind is active; where it considers any thing with some degree of voluntary attention: For in bare *perception* the mind is, for the most part, only *passive*; and what it perceives, it cannot avoid perceiving. What this is, we cannot otherwise know, than by reflecting on what passes in our minds when we see, feel, hear, &c.

Retention.

37. Impressions made on the outward parts, if they are not taken notice of within, cause no perception; as we see in those whose minds are intently buied in the contemplation of certain objects.

38. We may observe, that the ideas we receive from sensation, are often in grown people altered by the judgment, without our taking notice of it! Thus a globe of any uniform colour, as of gold or jet, being set before our eyes, the *idea* thereby imprinted is of a flat circle variously shadowed: But being accustomed to perceive what kind of appearance convex bodies are wont to make in us, the judgment alters the appearance into their causes; and, from that variety of shadow or colour, frames to itself the perception of a convex figure of one uniform colour. This in many cases, by a settled habit, is performed so readily, that we take that for the perception of our sensation, which is but an idea formed by the judgment; so that one serves only to excite the other, and is scarce taken notice of itself: As a man who reads or hears with attention, takes little notice of the characters or sounds, but of the ideas that are excited in him by them.

39. Perception is also the first step and degree towards knowledge, and the inlet of all the materials of it; so that the fewer senses any man has, and the duller the impressions that are made by them, are, the more remote he is from that knowledge which is to be found in other men.

#### SECT. IX. Of Retention.

40. THE next faculty of the mind whereby it makes a further progress towards knowledge, is called *retention*; which is the keeping of those ideas it has received. Which is done two ways:

41. *First*, By keeping the idea which is brought in to the mind for some time actually in view; which is called *contemplation*.

42. *Secondly*, By reviving those ideas in our minds which have disappeared, and have been, as it were, laid out of sight: And this is *memory*; which is, as it were, the store-house of our ideas; for the narrow mind of man not being capable of having many ideas under view at once, it was necessary to have a repository to lay up those ideas, which at another time it may have use of. But our ideas being nothing but actual perceptions in the mind, which cease to be any thing when there is no perception of them, this laying up of our ideas in the repository of the memory signifies no more but this, that the mind has a power, in many cases, to revive perceptions it has once had, with this additional perception annexed to them, that it has had them before. And it is by the assistance of this faculty, that we are said to have all those ideas in our understandings which we can bring in sight, and make the objects of our thoughts, without the help of those sensible qualities which first imprinted them there.

43. Those ideas that are often refreshed by a frequent return of the objects or actions that produce them, fix themselves best in the memory, and remain longest there: Such are the *original qualities of bodies*. viz. Solidity, extension, figure, motion, &c. These and the like are felt almost quite lost while the mind retains any ideas at all.

#### SECT. X. Of Discerning, and other Operations of the Mind.

Complex Ideas.

44. ANOTHER faculty of the mind, is that of *discerning between its ideas*. On this depends the evidence and certainty of several general propositions. In being able nicely to distinguish one thing from another, where there is the least difference, consists, in a great measure, that *exactness of judgment and clearness of reason* which is to be observed in one man above another.

45. To the well distinguishing our ideas, it chiefly contributes that they be clear and determinate; and when they are so, it will not breed any confusion or mistake about them, though the senses should convey them from the same object differently on different occasions.

46. The comparing of our ideas one with another in respect of *extent, degree, time, place*, or any other circumstances, is another operation of the mind about its ideas, which is the ground of *relations*. Brutes seem not to have this faculty in any great degree. They have probably several ideas distinct enough; but cannot compare them farther than some sensible circumstances annexed to the objects themselves.

47. *Composition* is another operation of the mind, whereby it combines several of its simple ideas into complex ones: Under which operation we may reckon that of *enlarging*; wherein we put several ideas together of the same kind, as several units to make a *dozen*.

48. *Abstraction* is another operation of the mind, whereby the mind forms general ideas from such as it received from particular objects; which it does by considering them, as they are in the mind such appearances separate from the circumstances of real existence, as *time, place, &c.* These become general *representatives* of all the same kind, and their names applicable to whatever exists conformable to such abstract ideas. Thus the colour received from *chalk, snow, and milk*, is made a representative of all of that kind; and has a name given it (*whiteness*), which signifies the same quality, wherever to be found or imagined. And thus *universals*, both ideas and terms, are made.

#### SECT. XI. Of Complex Ideas.

49. IN the reception of simple ideas the mind is only *passive*, having no power to frame any one to itself, nor having any idea which does not wholly consist of them. But about these simple ideas it exerts several acts of its own, whereby out of them, as the materials and foundations of the rest, the others are framed. The acts of the mind, wherein it exerts its power over its simple ideas, are chiefly these three. *First*, It combines several simple ideas into one compound one; and thus all *complex ideas* are made. *Secondly*, It brings two ideas, whether *simple or complex*, together, and sets them by one another, so as to take a view of them at once, without uniting them into one; by which way it gets all its ideas of relations. *Thirdly*, It separates them from all other ideas that accompany them in their real existence: And thus all its *general ideas* are made. As *simple ideas* are observed to exist in several combinations united together, so the mind may consider them as united, not only as they are really

Of Space.

really united in external objects, but as itself has joined them. *Ideas* thus made up of several ones put together, are called *complex*; as *man*, *army*, *beauty*, *gratitude*, &c. By this faculty of repeating and joining together its *ideas*, the mind has great power in varying and multiplying the objects of its thoughts. But it is still confined to those simple *ideas* which it received from the two sources of *sensation* and *reflection*. It can have no other *ideas* of sensible qualities than what come from without by the senses, nor any other *ideas* of the operations of a thinking substance than what it finds in itself; but having once got these simple *ideas*, it can by its own power put them together, and make new *complex ones*, which it never received to united.

50. *Complex ideas*, however compounded and decomposed, though their number be infinite, and their variety endless, may all be reduced under these three heads: 1<sup>st</sup>, *Modes*; 2<sup>dly</sup>, *Substances*; 3<sup>dly</sup>, *Relations*.

51. First, *Modes* are such *complex ideas* as contain not the supposition of subsisting by themselves; but are considered as dependences on, and affections of, substances; as *triangle*, *gratitude*, *murder*, &c. These modes are of two sorts: First, *Simple*; which are combinations of the same simple *idea* as a *dozen*, *score*, &c. which are but the *ideas* of so many distinct units put together. Secondly, *Mixed*; which are compounded of simple *ideas* of several kinds; as *beauty*, which consists in a certain composition of colour and figure, causing delight in the beholder; *thief*, which is the concealed change of the possession of any thing, without the consent of the proprietor. These visibly contain a combination of *ideas* of several kinds.

52. Secondly, *Substances*. The *ideas* of substances are only such combinations of simple *ideas*, as are taken to represent distinct particular things subsisting by themselves, in which the confused *idea* of substance is always the chief. Thus a combination of the *ideas* of a certain figure, with the powers of motion, thought, and reasoning, joined to substance, make the ordinary *idea* of man.

53. These again are either of *single substances*, as *man*, *stone*; or of *collective*, or several put together, as *army*, *heap*. *Ideas* of several substances thus put together, are as much each of them one *single idea*, as that of a *man* or an *unit*.

54. Thirdly, *Relations*; which consist in the consideration and comparing of one *idea* with another. Of these several kinds we shall treat in their order.

#### SECT. XII. Of Simple Modes: And, first, of the simple modes of Space.

55. CONCERNING *simple modes* we may observe, that the modifications of any *simple ideas* are as perfectly different and distinct ideas in the mind, as those of the greatest distance or contrariety: Thus *two* is as distinct from *three*, as *blueness* from *heat*.

56. *Space* is a simple *idea* which we get both by our sight and touch. When we consider it barely in length between two bodies, it is called *distance*: when in length, breadth, and thickness, it may be called *capacity*. When considered between the extremities of matter, which fills the capacity of space with something solid, tangible, and moveable, it is called

*extension*. And thus *extension* will be an *idea* belonging to body; *space* may be conceived without it.

57. Each different *distance* is a different modification of space; and each *idea* of any different space is a *simple mode* of this *idea*. Such are an *inch*, *foot*, *yard*, &c. When these *ideas* are made familiar to mens thoughts, they can in their minds repeat them as often as they will, without joining to them the *idea* of body, and frame to themselves the *ideas* of feet, yards, or fathoms, beyond the utmost bounds of all bodies; and by adding these fill one to another, enlarge their *idea* of space as much as they please. From this power of repeating any *idea* of distance, without being ever able to come to an end, we come by the *idea* of immensity.

58. Another modification of *space* is taken from the *relation* of the parts of the termination of extension or circumscribed space amongst themselves; and this is what we call *figure*. This the *touch* discovers in sensible bodies, whose extremities come within our reach; and the *eye* takes both from bodies and colours, whose boundaries are within its view; where observing how the extremities terminate either in straight lines, which meet at discernible angles, or in crooked lines, wherein no angles can be perceived; by considering these as they relate to one another in all parts of the extremities of any body or space, it has that *idea* we call *figure*: which affords to the mind infinite variety.

59. Another *mode* belonging to this head, is that of *place*. Our *idea* of *place* is nothing but the relative position of any thing with reference to its distance from some fixed and certain points. Whence we say, that a thing has or has not changed *place*, when its distance either is or is not altered with respect to those bodies with which we have occasion to compare it. That this is so, we may easily gather from hence, that we can have no *idea* of the *place* of the universe, though we can of all its parts. To say that the world is *somewhere*, means no more than that it does exist. The word *place* is sometimes taken to signify that *space* which any body takes up; and so the universe may be conceived in a *place*.

#### SECT. XIII. Of Duration, and its Simple Modes.

60. THERE is another sort of *distance*, the *idea* of which we get from the fleeting and perpetually perishing parts of succession, which we call *duration*. The simple modes of it are any different lengths of it whereof we have distinct *ideas*; as *hours*, *days*, *years*, &c. *time* and *eternity*.

61. The *idea* of *succession* is got by reflecting on that train of *ideas* which constantly follow one another in our minds as long as we are awake. The distance between any parts of this *succession*, is what we call *duration*; and the continuation of the existence of ourselves, or any thing else, *commensurate* to the succession of any *ideas* in our minds, is what we call our *own duration*, or that of another thing co-existing with our thinking. That this is so, appears from hence, that we have no perception of succession or duration, when that succession of our *ideas* ceases, as in *sleep*: the moment that we sleep, and awake, how distant soever, seems to be joined and connected. And possibly it would be so to a waking man, could he fix upon one *idea* without variation and the succession of others. And we see that they



Of  
Number.

they whose thoughts are very intent upon one thing, let slip out of their account a good part of that *duration*, and think that time shorter than it is. But if a man, during his sleep, *dream*, and a variety of *ideas* make themselves perceptible in his mind one after another, he hath then, during such dreaming, a sense of *duration*, and of the length of it.

A man having once got this *idea* of duration, can apply it to things which exist while he does not think: and thus we measure the time of our sleep, as well as that wherein we are awake.

Duration, as marked by certain periods and measures, is what we most properly call *time*; which we measure by the diurnal and annual *revolutions* of the sun, as being constant, regular, and universally observable by all mankind, and supposed equal to one another.

The mind having once got such a measure of *time*, as the annual revolution of the sun, can easily apply it to duration wherein that measure itself did not exist; and the *idea* of duration equal to an annual revolution of the sun, is as easily applicable in our thoughts to duration where no sun nor motion was, as the *idea* of a foot or yard to distances beyond the confines of the world.

By the same means, and from the same original that we come to have the *idea* of time, we have also that *idea* which we call *eternity*: for having got the *ideas* of certain lengths of duration, we can in our thoughts add them to one another as oft as we please, without ever coming to an end.

And thus it is plain, that from the two fountains of all knowledge before mentioned, *viz. sensation and reflection*, we get the *ideas* of duration, and the several measures of it.

## SECT. XIV. Of Number.

62. THE complex *ideas* of number are formed by adding several *units* together. The *simple modes* of it are each several combinations, as *two, three, &c.* These are of all others most distinct, the nearest being as clearly different from each other as the most remote: *two* being as distinct from *one*, as two hundred. But it is hard to form distinct *ideas* of every the least excess in extension. Hence demonstrations in numbers are more general in their use, and more determinate in their application, than those of extension.

63. *Simple modes* of numbers being in our minds but so many combinations of units, which have no variety but *more or less*; names for each distinct combination seem more necessary than in any other sort of *ideas*: For without a name, or mark, to distinguish that precise collection, it will hardly be kept from being a heap of confusion. Hence some *Americans* have no distinct *idea* of any number beyond twenty; so that when they are discoursed with of greater numbers, they shew the hairs of their head. So that to reckon right, two things are required.

64. *First*, That the mind distinguish carefully two *ideas* which are different one from another only by the addition or subtraction of one unit.

65. *Secondly*, That it retain in memory the names or marks of the several combinations, from an unit to that number; and that in exact order, as they follow one another. In either of which if it fails, the whole

business of *numbering* will be disturbed; and there will remain only the confused *idea* of multitude; but the *ideas* necessary to distinct numeration will not be attained to.

## SECT. XV. Of Infinity.

66. THE *idea* signified by the name *infinity*, is best examined, by considering to what infinity is by the mind attributed, and then how it frames it. *Finite* and *infinite*, then, are looked upon as the modes of quantity; and attributed primarily to things that have parts, and are capable of increase or diminution by the addition or subtraction of any the least part. Such are the *ideas* of *space, duration, and number*.

67. When we apply this *idea* to the *Supreme Being*, we do it primarily, in respect of his duration and ubiquity; more figuratively, when to his *wisdom, power, goodness*, and other attributes, which are properly *inexhaustible* and *incomprehensible*: for when we call them infinite, we have no other *idea* of this infinity, but what carries with it some reflection on the number or the extent of the *acts* or *objects* of God's power and wisdom, which can never be supposed too great, or so many, that these attributes will not always surmount and exceed, though we multiply them in our thoughts with the infinity of *endless number*.

68. The next thing to be considered, is, *How we come by the idea* of infinity. Every one that has any *idea* of any stated lengths of space, as a *foot, yard, &c.* finds that he can repeat that *idea*, and join it to another, to a *third*, and so on without ever coming to an end of his additions. From this power of enlarging his *idea* of space, he takes the *idea* of infinite space, or *immensity*. By the same power of repeating the *idea* of any length of duration we have in our minds, with all the endless addition of number, we come by the *idea* of *eternity*.

69. If our *idea* of infinity be got by repeating without end our own *ideas*; why do we not attribute it to other *ideas*, as well as those of *space and duration*; since they may be as easily and as often repeated in our minds as the other? yet nobody ever thinks of infinite *sweetness* or *whiteness*, though he can repeat the *idea* of sweet or white as frequently as those of *yard* or *day*. But those *ideas* that have parts, and are capable of increase by the addition of any parts, afford us, by their repetition, an *idea* of infinity; because with the endless repetition there is continued an enlargement, of which there is no end. But it is not so in other *ideas*: for if to the perfect *idea* I have of white, I add another of equal whiteness, it enlarges not my *idea* at all. Those *ideas* that consist not of parts, cannot be augmented to what proportion men please, or be stretched beyond what they have received by their senses: but *space, duration, and number*, being capable of increase by repetition, leave in the mind an *idea* of an endless room for more; and so those *ideas* alone lead the mind towards the thought of infinity.

## SECT. XVI. Of the Modes of Thinking.

70. WHEN the mind turns its view inwards upon itself, *thinking* is the first *idea* that occurs: wherein it observes a great variety of modifications; and thereof frames to itself distinct *ideas*. Thus the perception annexed to any impression on the body made by an external

ternal object, is called *sensation*. When an *idea* recurs without the presence of the object, it is called *remembrance*: when sought after by the mind, and brought again in view, it is *recollection*: when held there long under attentive consideration, it is *contemplation*. When *ideas* float in the mind without regard or reflection, it is called in French *revêrie*: our language has scarce a name for it: When the *ideas* are taken notice of, and as it were registered in the memory, it is *attention*: When the mind fixes its view on any one *idea*, and considers it on all sides, it is *intention* and *study*. *Sleep*, without dreaming, is rest from all these: And *dreaming* is the perception of *ideas* in the mind, not suggested by any external objects, or known occasions; nor under any choice or conduct of the understanding.

#### SECT. XVII. *Of the Modes of Pleasure and Pain.*

71. PLEASURE and pain are simple *ideas*, which we receive both from sensation and reflection. There are thoughts of the mind, as well as sensations, accompanied with pleasure or pain. Their causes are termed *good* or *evil*. Pleasure and pain, and their causes *good* and *evil*, are the hinges upon which our passions turn; by reflecting on the various modifications or tempers of mind, and the internal sensations which pleasure and pain, good and evil, produce in us, we may thence form to ourselves the *ideas* of our passions. Thus by reflecting upon the thought we have of the delight which any thing is apt to produce in us, we have an *idea* we call *love*: and on the contrary, the thought of the pain which any thing present or absent produces in us, is what we call *hatred*. *Desire* is that uneasiness which a man finds in himself upon the absence of any thing the present enjoyment of which carries the *idea* of delight with it. *Joy* is a delight of the mind arising from the present or assured approaching possession of a good. *Sorrow* is an uneasiness of the mind, upon the thought of a good lost, or the sense of a present evil. *Hope* is a pleasure in the mind, upon the thought of a probable future enjoyment of a thing which is apt to delight. *Fear* is an uneasiness of the mind, upon the thought of a future evil likely to befall us. *Anger* is a discomposure of the mind, upon the receipt of injury, with a present purpose of revenge. *Despair* is the thought of unattainableness of any good. *Envy* is an uneasiness of the mind, caused by the consideration of a good we desire, obtained by one we think should not have had it before us.

72. It is to be considered, that, in reference to the passions, the removal or lessening of a pain is considered and operates as a pleasure; and the loss or diminishing of a pleasure, as a pain: And farther, that the passions in most persons operate on the body, and cause various changes in it; but these being not always sensible, do not make a necessary part of the *idea* of each passion.

#### SECT. XVIII. *Of Power.*

73. THE mind being every day informed by the senses of the alteration of those simple *ideas* it observes in things without, reflecting also on what passes within itself, and observing a constant change of its *ideas*, sometimes by the impressions of outward objects upon the senses, and sometimes by the determination of its

own choice; and concluding, from what it has so constantly observed to have been, that the like changes will for the future be made in the same things, by the same agents, and by the like ways, considers in one thing the possibility of having any of its simple *ideas* changed, and in another the possibility of making that change, and so comes by that *idea* which we call *power*. Thus we say *fire* has a power to melt gold, and make it fluid; and gold has a power to be melted.

74. Power thus considered, is twofold, viz. as able to make, or able to receive any change: the one may be called *active*, the other *passive power*. Of *passive power* all sensible things abundantly furnish us with *ideas*, whose sensible qualities and beings we find to be in a continual flux. Nor have we of *active power* fewer instances; since whatever change is observed, the mind must collect a power somewhere able to make that change. But yet, if we will consider it attentively, bodies by our senses do not afford us so clear and distinct an *idea* of *active power* as we have from reflection on the operation of our minds. For all power relating to action, and there being but two sorts of action, viz. *thinking* and *motion*, let us consider whence we have the clearest *ideas* of the powers which produce these actions.

75. *Of thinking* body affords us no *idea* at all: it is only from reflection that we have that; neither have we from body any *idea* of the beginning of motion. A body at rest, affords us no *idea* of any *active power* to move; and when it is set in motion itself, that motion is rather a passion than action in it. The *idea* of the beginning of motion, we have only by reflection on what passes in ourselves; where we find by experience, that barely by willing it, we can move the parts of our bodies which were before at rest.

We find in ourselves a power to begin or forbear, continue or end, several actions of our minds, and motions of our bodies, barely by a thought, or preference of the mind. This power which the mind has thus to order the consideration of any *idea*, or the forbearing to consider it; or to prefer the motion of any part of the body to its rest, and *vice versa*, in any particular instance, is that we call the *will*; the actual exercise of that power is that which we call *volition* or *willing*. The forbearance or performance of that action, consequent to such order or command of the mind, is called *voluntary*; and whatsoever action is performed without such a thought of the mind, is called *involuntary*.

77. The power of perception is that we call the *understanding*. *Perception*, which we make the act of the understanding, is of three sorts: 1<sup>st</sup>, The perception of *ideas* in our minds. 2<sup>dly</sup>, The perception of the signification of signs. 3<sup>dly</sup>, The perception of the agreement or disagreement of any distinct *ideas*. These powers of the mind, viz. of perceiving and preferring, are usually called by another name; and the ordinary way of speaking is, that the understanding and will are two *faculties* of the mind.

78. From the consideration of the extent of the power of the mind over the actions of the man, which every one finds in himself, arise the *ideas* of *liberty* and *necessity*: so far as a man has a power to think or not to think, to move or not to move, according to the preference or direction of his own mind, so far is a man free.

free. Wherever any performance or forbearance are not equally in a man's power; wherever doing, or not doing, will not equally follow upon the preference of his mind; there he is not free, though perhaps the action may be voluntary. So that the *idea of liberty* is the *idea* of a power in any agent to do or forbear any action, according to the determination or thought of the mind whereby either of them is preferred to the other. Where either of them is not in the power of the agent to be produced by him according to his volition, there he is not at liberty; that agent is under necessity. So that *liberty* cannot be where there is no *thought, no volition, no will*; but there may be thought, there may be will, there may be volition, where there is no *liberty*. Thus a *tennis-ball*, whether in motion by the stroke of a racket, or lying still at rest, is not by any one taken to be a free agent. So a man striking himself or his friend by a convulsive motion of his arm, which it is not in his power by volition or the direction of his mind to stop or forbear; nobody thinks he has in this *liberty*; every one pities him, as acting by necessity and constraint. Again, suppose a man be carried while fast asleep into a room where is a person he longs to see, and be there locked fast in beyond his power to get out; he awakes, and is glad to see himself in so desirable company: which he stays willingly in, that is, prefers his staying to going away. Is not this stay voluntary? no body will doubt it; and yet being locked fast in, he is not at liberty to stay, he has not freedom to be gone. So that *liberty* is not an *idea* belonging to volition or preferring, but to the person having the power of doing, or forbearing to do, according as the mind shall choose or direct.

79. As it is in the motions of the body, so it is in the thoughts of our minds: where any one is such, that we have power to take it up, or lay it by, according to the preference of the mind, there we are at liberty. A waking man is not at liberty to think, or not to think, no more than he is at liberty whether his body shall touch any other or no: but whether he will remove his contemplation from one *idea* to another, is many times in his choice. And then he is, in respect of his *ideas*, as much at liberty, as he is in respect of bodies he rests on. He can at pleasure remove himself from one to another: but yet some *ideas* to the mind, like some motions to the body, are such, as in certain circumstances it cannot avoid, nor obtain their absence by the utmost effort it can use. Thus a man on the rack is not at liberty to lay by the *idea of pain*, and entertain other contemplations.

80. Wherever thought is wholly wanting, or the power to act or forbear according to the direction of thought, there necessity takes place. This, in an agent capable of volition, when the beginning or continuation of any action is contrary to the preference of his mind, is called *compulsion*; when the hindering or stopping any action is contrary to his volition, it is called *restraint*: agents that have no thought, no volition at all, are in every thing necessary agents.

#### SECT. XIX. Of Mixed Modes.

81. *Mixed modes* are combinations of *simple ideas* of different kinds. The mind being once furnished with *simple ideas*, can put them together in several compositions, without examining whether they exist

together in nature. And hence it is that these *ideas* are called *notions*, as if they had their original and constant existence more in the thoughts of men than in the reality of things: and to form such *ideas*, it sufficed that the mind put the parts of them together, and that they were consistent in the understanding, without considering whether they had any real being. There are three ways whereby we get these complex *ideas of mixed modes*.

1<sup>st</sup>, By experience, and observation of things themselves: Thus by seeing two men wrestle, we get the *idea of wrestling*.

2<sup>dly</sup>, By invention, or voluntary putting together of several *simple ideas* in our own minds: So he that first invented *printing*, had an *idea* of it first in his mind before it ever existed.

3<sup>dly</sup>, By explaining the names of actions we never saw, or nations we cannot see; and by enumerating all those *ideas* which go to the making them up. Thus the mixed mode, which the word *lie* stands for, is made up of these *simple ideas*: 1<sup>st</sup>, *Articulate sounds*. 2<sup>dly</sup>, *Certain ideas in the mind of the speaker*. 3<sup>dly</sup>, *Those words, the signs of these ideas*. 4<sup>thly</sup>, *Those signs put together*, by affirmation or negation, otherwise than the *ideas* they stand for are in the mind of the speaker. Since languages are made, *complex ideas* are usually got by the explication of those terms that stand for them: for since they consist of *simple ideas* combined, they may, by words standing for those *simple ideas*, be represented to the mind of one who understands those words, though that combination of *simple ideas* was never offered to his mind by the real existence of things.

82. *Mixed modes* have their *unity* from an act of the mind, combining those several *simple ideas* together, and considering them as one complex one: the mark of this union is one name given to that combination. Men seldom reckon any number of *ideas* to make one complex one: but such collections as there be names for. Thus the *killing of an old man*, is as fit to be united into one *complex idea* as that of a *father*: yet there being no name for it, it is not taken for a particular complex *idea*, nor a distinct species of action from that of killing any other man.

83. Those collections of *ideas* have names generally affixed which are of frequent use in conversation: in which cases, men endeavour to communicate their thoughts to one another with all possible dispatch. Those others, which they have seldom occasion to mention, they tie not together nor give them names.

84. This gives the reason why there are words in every language which cannot be rendered by any one single word of another. For the fashions and customs of one nation make several combinations of *ideas* familiar in one which another had never any occasion to make. Such were *opprobriums* among the Greeks, *proscriptio* among the Romans. This also occasions the constant change of languages; because the change of custom and opinions brings with it new combinations of *ideas*, which, to avoid long descriptions, have new names annexed to them, and so they become new species of mixed modes.

85. Of all our *simple ideas*, those that have had most *mixed modes* made out of them, are, *thinking* and *motion*, which comprehend in them all action; and

Substance.

power, from whence these actions are conceived to flow. For actions being the great business of mankind, it is no wonder if the several modes of thinking and motion should be taken notice of, the *ideas* of them observed and laid up in memory, and have names assigned them. For without such *complex ideas* with names to them, men could not easily hold any communication about them. Of this kind are the modes of actions distinguished by their *causes, means, objects, ends, instruments, time, place, and other circumstances*: as also of the powers fitted for those actions. Thus *boldness* is the power to do or speak what we intend, without fear or disorder: which power of doing any thing, when it has been acquired by the frequent doing the same thing, is that *idea* we call *habit*; when forward, and ready upon every occasion, to break into action, we call it *disposition*: thus *testiness* is a disposition or aptness to be angry.

86. Power being the source of all action, the substances wherein these powers are, when they exert this power, are called *causes*; and the substances thereupon produced, or the simple *ideas* introduced into any subject, *effects*. The efficacy whereby the new substance or *idea* is produced, is called, in the subject exerting that power, *action*; in the subject, wherein any simple *idea* is changed or produced, *passion*: Which efficacy, in *intellectual agents*, we can conceive to be nothing else but modes of thinking and willing; in *corporeal agents*, nothing else but modifications of motion.

#### SECT. XX. Of our Complex Ideas of Substances.

87. The mind observing several simple *ideas* to go constantly together, which being presumed to belong to one thing, are called, by us, in one subject, by one name, which we are apt afterward to talk of and consider as one simple *idea*, which indeed is a complication of many *ideas* together. We imagine not these simple *ideas* to subsist by themselves: but suppose some *substratum* wherein they subsist, which we call *substance*. The *idea* of pure substance is nothing but the supposed (but unknown) support of those qualities which are capable of producing simple *ideas* in us.

88. The *ideas* of particular circumstances are composed out of this obscure and general *idea* of substance, together with such combinations of simple *ideas* as are observed to exist together, and supposed to flow from the internal constitution and unknown essence of that substance. Thus we come by the *ideas* of *man, horse, gold, &c.* Thus the sensible qualities of *iron, or a diamond*, make the complex *ideas* of those substances which a smith or a jeweller commonly knows better than a philosopher.

89. The same happens concerning the operations of the mind, *viz. thinking, reasoning, &c.* which we concluding not to subsist by themselves, nor apprehending how they can belong to body, or be produced by it, we think them the action of some other substance, which we call *spirit*: of whose substance or nature we have as clear a notion as of that of body; the one being but the supposed *substratum* of the simple *ideas* we have from without, as the other of those operations which we experiment in ourselves within: So that the *idea* of *corporeal substance* in

matter, is as remote from our conceptions as that of *spiritual substance*. Relation.

90. Hence we may conclude, that he has the perfect *idea* of any particular substance who has collected most of those simple *ideas* which do exist in it; among which we are to reckon its *active powers* and *passive capacities*, though not strictly *simple ideas*.

91. *Secondary qualities*, for the most part, serve to distinguish substance. For our senses fail us in the discovery of the *bulk, figure, texture, &c.* of the minute parts of the bodies, on which their real constitutions and differences depend; and secondary are nothing but powers, with relation to our sense. The *ideas* that make our complex ones of corporeal substances are of three sorts: First, The *ideas* of primary qualities of things, which are discovered by our senses; such are *bulk, figure, motion, &c.* Secondly, The sensible secondary qualities; which are nothing but powers to produce several *ideas* in us by our senses. Thirdly, The aptness we consider in any substance to cause or receive such alterations of primary qualities, as that the substance so altered should produce in us different *ideas* from what it did before; and they are called *active* and *passive powers*. All which, as we have any notice or notion of them, terminate in *simple ideas*.

92. Had we senses acute enough to discern the minute particles of bodies, it is not to be doubted but they would produce quite different *ideas* in us; as we find in viewing things with *microscopes*. Such bodies as to our naked eyes are coloured and opaque, will through *microscopes* appear pellucid. *Blood* to the naked eye appears all red; but by a good *microscope* we see only some red globules swimming in a transparent liquor.

93. Besides these complex *ideas* we have of material substances; by the simple *ideas* taken from the operations of our own minds, which we experiment in ourselves, as *thinking, understanding, willing, knowing, &c.* co-existing in the same substance, we are able to frame the complex *idea* of a *spirit*. And this *idea* of an *immaterial substance*, is as clear as that we have of a *material*. By joining these with substance, of which we have no distinct *idea*, we have the *idea* of a *spirit*: And by putting together the *ideas* of coherent solid parts, and power of being moved, joined with substance, of which likewise we have no positive *idea*, we have the *idea* of *matter*. The one is as clear and distinct as the other. The substance of *spirit* is unknown to us; and so is the substance of *body* equally unknown to us. Two primary qualities or properties of body, *viz. solid coherent parts, and impulse*, we have distinct clear *ideas* of: So likewise we have of two primary qualities or properties of spirit, *viz. thinking, and a power of action*. We have also clear and distinct *ideas* of several qualities inherent in bodies, which are but the various modifications of the extension of coherent solid parts and their motion. We have likewise the *ideas* of the several modes of thinking, *viz. Believing, doubting, hoping, fearing, &c.* as also of willing and moving the body consequent to it.

#### SECT. XXI. Of Relation.

94. THERE is another set of *ideas* which the mind gets

Of Cause  
and Effect.

gets from the comparing of one thing with another. When the mind fo considers one thing, that it does as it were bring it to and fet it by another, and carry its view from one to the other, this is *relation* or *refpeft*; and the denominations given to things intimating that refpeft, are what we call *relatives*, and the things fo brought together *related*. Thus when I call *CAJUS, husband*, or *whiter*, I intimate fome other perfon, or thing, in both cafes, with which I compare him: Any of our *ideas* may be the foundation of relation.

95. Where languages have failed to give correlative names, there the relation is not fo eafily taken notice of: As in *concubines*, which is a relative name as well as *wife*.

96. The *ideas* of relation may be the fame in thofe men who have far different *ideas* of the things that are related. Thus thofe who have different *ideas* of *man*, may agree in that of *father*.

97. There is no *idea* of any kind which is not capable of an almoft infinite number of confiderations, in reference to other things; and therefore this makes no fmall part of mens words and thoughts. Thus one fingle man may at once fustain the relations of *father, brother, fon, husband, friend, fubjeft, general, European, Englifhman, iflander, mafter, fervant, bigger, left*, &c. to an almoft infinite number; he being capable of as many relations as there may be occafions of comparing him to other things in any manner of agreement, difagreement, or refpeft whatsoever.

SECT. XXII. Of Cause and Effect, and other Relations.

98. THE *ideas* of *caufe* and *effect* we get from our obfervation of the *vicifitude* of things, while we perceive fome qualities or fubftances begin to exift, and that they receive their exiftence from the due application and operation of other things: That which *produces*, is the *caufe*; that which is *produced*, the *effect*. Thus *fluidity* in wax is the effect of a certain degree of heat, which we obferve to be conftantly produced by the application of fuch heat.

99. We diftinguifh the originals of things into two forts.

100. Firft, When the thing is wholly made new, fo that no part thereof did ever exift before, as when a new particle of matter doth begin to exift which had before no being, it is called *creation*.

101. Secondly, When a thing is made up of particles which did all of them before exift, but the thing fo conftituted of pre-exiftent particles, which all together make up fuch a collection of fimple *ideas*, had not any exiftence before; as this *man*, this *egg*, this *rofe*, &c.: this, when referred to a fubftance produced in the ordinary courfe of nature by an internal principle, but fet on work by fome external agent, and working by infenfible ways which we perceive not, is called *generation*: When the caufe is extrinfical, and the effect produced by a fenfible feparation, or juxtapofition of difcernible parts, we call it *making*: and fuch are all artificial things. When any fimple *idea* is produced, which was not in that fubjeft before, we call it *alteration*.

102. The denomination of things taken from *time*

are for the moft part only relations. Thus when it is faid that queen *Elizabeth* lived fixty-nine, and reigned forty-five years, no more is meant, than that the duration of her exiftence was equal to fixty-nine, and of her government to forty-five annual revolutions of the fun.

103. *Young* and *old*, and other words of time, that are thought to ftand for pofitive *ideas*, are indeed relative; and intimate a relation to a certain length of duration, whereof we have the idea in our minds. Thus we call a man *young* or *old*, that has lived little or much of that time that men ufually attain to. This is evident from our application of thefe names to other things; for a man is called *young* at twenty, but a horfe *old*, &c. The fun and ftars we call not *old* at all, becaufe we know not what period God has fet to that fort of beings.

104. There are other ideas that are truly *relative*, which we fignify by names that are thought *pofitive* and *abfolute*; fuch as *great* and *little*, *ftong* and *weak*. The things thus denominated, are referred to fome ftandards, with which we compare them. Thus we call an apple *great*, that is bigger than the ordinary fort of thofe we have been ufed to; and a man *weak*, that has not fo much ftrength or power to move as men ufually have.

SECT. XXIII. Of Identity and Diversity.

105. ANOTHER occafion the mind takes of comparing is, the very *being* of things. When confidering a thing as exifting at any certain time or place, and comparing it with itfelf as exifting at any other time, &c. it forms the ideas of *identity* and *diverfity*. When we fee any thing in any certain time and place, we are fure it is that very thing, and can be no other, how like foever it may be in all other refpefts.

106. We conceiving it to be impoffible that two things of the fame kind fhould exift together in the fame place, we conclude, that whatever exifts any where at the fame time, excludes all of the fame kind, and is there itfelf alone. When therefore we demand whether any thing be the *fame*, or no, it refers always to fomething that exifted fuch a time, in fuch a place, which it was certain at that inflant was the fame with itfelf, and no other.

107. We have ideas of three forts of fubftances: 1. Of *God*. 2. *Finite intelligences*. 3. *Bodies*.

Firft, God being eternal, unalterable, and everywhere, concerning his *identity* there can be no doubt.

Secondly, Finite fpirits having had their determinate time and place of beginning to exift, the relation to that time and place will always determine to each its *identity* as long as it exifts.

Thirdly, The fame will hold of every particle of matter to which no addition or fubtraction is made. Thefe three exclude not one another out of the fame place, yet each exclude thofe of the fame kind out of the fame place.

108. The identity and diverfity of *modes* and *relations* are determined after the fame manner that fubftances are; only the actions of finite beings, as *motion* and *thought*, confifting in fucceffion, they cannot exift in different times and places as permanent beings: for no motion or thought, confidered as at different

identity  
and  
Diverfity.

times, can be the same, each part thereof having a different beginning of existence.

109. From whence it is plain, that existence itself is the *principium individuationis*, which determinates a being to a particular time and place incommunicable to two beings of the same kind. Thus, suppose an *atom* existing in a determined time and place; it is evident that, considered in any instant, it is the same with itself, and will be so as long as its existence continues. The same may be said of two, or more, or any number of particles, whilst they continue together. The mass will be the same, however jumbled: but if one atom be taken away, it is not the same mass.

110. In *vegetables*, the identity depends not on the same mass, and is not applied to the same thing. The reason of this is, the difference between an animate body and mass of matter; *ibi* being only the cohesion of particles any-how united: *the other*, such a disposition, an organization of parts, as is fit to receive and distribute nourishment, so as to continue and frame the wood, bark, leaves, &c. (of an *oak*, for instance) in which consists the vegetable life. That therefore which has such an organization of parts partaking of one common life, continues to be the same *plant*, though that life be communicated to new particles of matter, vitally united to the living plant. The case is not so much different in *brutes*, but that any one may hence see what makes an *animal*, and continues it the same.

111. The identity of the *same man* likewise consists in a participation of the same continued life in succeeding particles of matter vitally united to the same organized body.

112. To understand *identity* aright, we must consider what *idea* the word it is applied to stands for; it being one thing to be the *same substance*, another the *same man*, and a third the *same person*.

113. An *animal* is a living organized body; and the same animal is the same continued life communicated to different particles of matter, as they happen successively to be united to that organized living body; and our notion of *man* is but of a particular sort of animal.

114. *Person* stands for an intelligent being, that reasons and reflects, and can consider itself the same thing in different times and places; which it doth by that *consciousness* that is inseparable from thinking. By this every one is to himself what he calls *self*, without considering whether that *self* be continued in the same or divers substances. In this consists *personal identity*, or the sameness of a rational being; and so far as this consciousness extends backward to any past action or thought, so far reaches the identity of that person. It is the same *self* now it was then: and it is by the same *self*, with this present one that now reflects on it, that that action was done.

115. *Self* is that conscious thinking thing, whatever substance it matters not, which is conscious of pleasure or pain, capable of happiness or misery; and so is concerned for itself as far as that consciousness extends. That with which the consciousness of this present thinking thing can join itself, makes the same person, and is one self with it; and so attributes to itself and owns all the actions of that thing as its own,

as far as that consciousness reaches.

116. This *personal identity* is the object of reward and punishment, being that by which every one is concerned for himself. If the *consciousness* went along with the little finger, when that was cut off, it would be the same felt that was just before concerned for the whole body.

117. If the same *Socrates*, waking and sleeping, did not partake of the same consciousness, they would not be the same *person*. *Socrates* waking, could not be in justice accountable for what *Socrates* sleeping did, no more than one *twin* for what his brother *twin* did because their outdies were so like that they could not be distinguished.

118. But suppose I wholly lose the memory of some parts of life, beyond a possibility of retrieving them, so that I shall never be conscious of them again: am I not the same *person* that did those actions, though I have now forgot them? I answer, that we must here take notice what the word *I* is applied to, which in this case is the man only: and the same man being presumed to be the same person, *I* is easily here supposed to stand also for the same person. But if it be possible for the same man to have distinct incommunicable consciousness at different times, it is past doubt the same man would, at different times, make different persons. Which we see is the sense of mankind in the solemnest declaration of their opinions, human laws not punishing the mad man for the sober man's actions, nor the sober man for what the mad man did; thereby making them two persons. Thus we say in *English*, such a one is *not himself*, or is *besides himself*; in which phrase, it is intimated, that *self* is changed, and the *self-same person* is no longer in that man.

119. But is not a man drunk or sober the same person? Why else is he punished for the same fact he commits when drunk, tho' he be never afterwards conscious of it? Just as much the same person as a man that walks and does other things in his sleep is the same person, and is answerable for any mischief he shall do in it. Human laws punish both with a justice suitable to their way of knowledge: because in these cases they cannot distinguish certainly what is real and what is counterfeited. And so the ignorance in drunkenness or sleep, is not admitted as a plea: for tho' punishment be annexed to personality, and personality to consciousness, and the drunkard, perhaps, is not conscious of what he did; yet human judicatures justly punish him, because the fact is proved against him, but want of consciousness cannot be proved for him.

120. To conclude: whatever substance begins to exist, it must during its existence be the same. Whatever compositions of substances begin to exist, during the union of those substances, the concrete must be the same. Whatsoever mode begins to exist, during its existence it is the same. And so if the composition be of distinct substances, and different modes, the same rule holds.

#### SECT. XXIV. Of other Relations.

121. ALL simple ideas, wherein are parts or degrees, afford an occasion of comparing the subjects wherein they are to one another, in respect of those simple ideas: As *sweeter*, *swifter*, *more*, *less*, &c.

These

Various Relations.

Various Relations.

These depending on the equality and excess of the same simple ideas, in several subjects, may be called *proportional relations*.

122. Another occasion of comparing things is taken from the circumstances of their origin; as *father, son, brother, &c.* These may be called *natural relations*.

123. Sometimes the foundation of considering things, is some act whereby any one comes by a moral right, power, or obligation to do something: Such are *general, captain, burgher*. These are *instituted and voluntary relations*; and may be distinguished from the *natural*, in that they are alterable and separable from the persons to whom they sometimes belonged, tho' neither of the substances so related be destroyed. But natural relations are not alterable, but are as lasting as their subjects.

124. Another relation is the conformity or disagreement of mens voluntary actions to a rule to which they are referred, and by which they are judged of: these may be called *moral relations*. It is this conformity or disagreement of our actions to some law (whereby good or evil is drawn on us from the will and power of the law-maker, and is what we call *reward or punishment*) that renders our actions morally good or evil.

125. Of these moral *rules or laws* there seem to be three sorts, with their different enforcements: first, *The divine law*; secondly, *Civil law*; thirdly, *The law of opinion or reputation*. By their relation to the first, our actions are either *sins or duties*; to the second, *criminal or innocent*; to the third, *virtues or vices*.

126. *First*, *The divine law* is that law which God has set to the actions of men, whether promulgated to them by the light of nature or the voice of revelation.

127. That God has given a law to mankind, seems undeniable, since he has, first, A right to do it; we are his creatures. Secondly, Goodness and wisdom, to direct our actions to what is best. Thirdly, Power to enforce it by reward and punishment, of infinite weight and duration. This is the only true touchstone of moral rectitude, and by which men judge of the most considerable moral good or evil of their actions; that is, whether, as duties or sins, they are like to procure to them happiness or misery from the hands of the Almighty.

128. *Secondly*, *The civil law* is the rule set by the commonwealth to the actions of those that belong to it. This law nobody overlooks; the rewards and punishments being ready at hand to enforce it, extending to the protecting or taking away of the life, liberty, and estate, of those who observe or disobey it.

129. *Thirdly*, *The law of opinion or reputation*. *Virtue and vice* are names supposed every where to stand for actions in their own nature right and wrong. As far as they are really so applied, they so far are consistent with the divine law. But it is visible that these names, in the particular instances of their application, through the several nations and societies of men, are constantly attributed only to such actions as in each country and society are in reputation or discredit. So that the measure of what is every where called and esteemed virtue and vice, is the approbation

or dislike, praise or blame, which by a tacit consent establishes itself in the societies and tribes of men in the world; whereby several actions come to find credit or disgrace amongst them, according to the judgment, maxims, or fashions of the place.

130. That this is so, appears hence: That tho' that passes for virtue in one place which is elsewhere accounted vice, yet every where *virtue and praise, vice and blame*, go together. *Virtue* is every where that which is thought praise-worthy; and nothing else but that which has the allowance of public esteem, is called *virtue*. These have to close an alliance, that they are often called by the same name.

131. It is true, virtue and vice do, in a great measure, every where correspond with the unchangeable rule of right and wrong, which the laws of God have established; because the observation of these laws visibly secures and advances the general good of mankind, and the neglect of them breeds mischief and confusion: and therefore men, without renouncing all sense and reason, and their own interest, could not generally mistake in placing their commendation and blame on that side that deserved it not.

132. They who think commendation and disgrace not sufficient motives to engage men to accommodate themselves to the opinions and rules of those with whom they converse, seem little skilled in the history of mankind; the greatest part whereof govern themselves by this *law of fashion*.

133. The penalties that attend the breach of God's laws are seldom seriously reflected on; and those that do reflect on them entertain thoughts of future reconciliation; and for the punishment due from the laws of the commonwealth, men flatter themselves with the hopes of impunity; but no man escapes censure and dislike, who offends against fashion; nor is there one of ten thousand stiff and insensible enough to bear up under the constant dislike and condemnation of his own club.

134. *Morality* then is nothing but a relation to these laws or rules: and these rules being nothing else but a collection of several simple ideas, the conformity thereto is but so ordering the action that the simple ideas belonging to it may correspond to those which the law requires. By which we see, how moral beings and notions are founded on and terminated in the simple ideas of sensation and reflection. For example; let us consider the complex idea signified by the word *murder*. First, from reflection, we have the ideas of *willing, considering, purposing, malice, &c.* also of *life, perception, and self-motion*. Secondly, from sensation, we have the ideas of *man*, and of some action whereby we put an end to that perception and motion in the man: all which simple ideas are comprehended in the word *murder*.

135. This collection of simple ideas being found to agree or disagree with the esteem of the country I have been bred in, and to be held worthy of praise or blame, I call the action *virtuous or vicious*. If I have the will of a supreme invisible Law-maker for my rule; then as I suppose the action commanded or forbidden by God, I call it *good or evil, sin or duty*: if I compare it with the civil law of my country, I call it *lawful or unlawful*, a crime or no crime.

136. Moral actions may be considered two ways: First,

First, As they are in themselves a collection of simple ideas; in which sense they are positive absolute ideas.

Secondly, As good, or bad, or indifferent: in this respect they are relative, it being their conformity or disagreement with some rule that makes them so. We ought carefully to distinguish between the positive idea of the action, and the reference it has to a rule, both which are commonly comprehended under one name, which often occasions confusion, and misleads the judgment.

137. Thus the taking from another what is his, without his consent, is properly called *stealing*: but that name being commonly understood to signify also the moral pravity of the action, men are apt to condemn whatever they hear called *stealing* as an ill action disagreeing with the rule of right. And yet the private taking away his sword from a madman, to prevent his doing mischief, though it be properly denominated *stealing*, as the name of such a mixed mode; yet, when compared to the law of God, it is no sin or transgression, tho' the name *stealing* ordinarily carries such an intimation with it.

SECT. XXV. Of Real and Fantastical Ideas.

138. OUR ideas, in reference to things from whence they are taken, or which they may be supposed to represent, come under a threefold distinction; and are, first, either real or fantastical; secondly, adequate or inadequate; thirdly, true or false.

139. Real ideas, are such as have a foundation in nature, such as have a conformity with the real being and existence of things, or with their archetypes.

140. Fantastical are such as have no foundation in nature, nor any conformity with that reality of being to which they are referred as to their archetypes. By examining the several sorts of ideas we shall find, that, first, our simple ideas are all real; not that they are images or representations of what does exist, but as they are the certain effects of powers in things without us, ordained by our Maker to produce in us such sensations: they are real ideas in us, whereby we distinguish the qualities that are really in things themselves.

141. Their reality lies in the steady correspondence they have with the distinct constitutions of real beings. But whether they answer to those constitutions as to causes or patterns, it matters not; it suffices that they are constantly produced by them.

142. Complex ideas, being arbitrary combinations of simple ideas put together, and united under one general name, in forming of which the mind uses its liberty, we must inquire which of these are real, and which imaginary combinations.

143. First, Mixed modes and relations having no other reality than what they have in the minds of men, nothing else is required to make them real, but a possibility of existing conformable to them. These ideas being themselves archetypes, cannot differ from their archetypes, and so cannot be chimerical; unless any one will jumble together in them inconsistent ideas. Those indeed that have names assigned them in any language, must have a conformity to the ordinary signification of the name that is given them, that they may not be thought fantastical.

144. Secondly, Our complex ideas of substances being made, in reference to things existing without us, whose representations they are thought, are no farther real than as they are such combinations of simple ideas as are really united, and co-exist in things without us: those are fantastical which are made up of several ideas that never were found united, as Centaur, &c.

SECT. XXVI. Of Ideas Adequate or Inadequate.

145. REAL ideas are either adequate or inadequate. First, adequate; which perfectly represents those archetypes which the mind supposes them taken from, and which it makes them to stand for. Secondly, Inadequate; which are such as do but partially or incompletely represent those archetypes to which they are referred. Whence it appears,

146. First, That all our simple ideas are adequate; for they being but the effects of certain powers in things fitted and ordained by God to produce such sensations in us, they cannot but be correspondent and adequate to such powers, and we are sure they agree to the reality of things.

147. Secondly, Our complex ideas of modes being voluntary collections of simple ideas, which the mind puts together without reference to any real archetypes, cannot but be adequate ideas. They are referred to no other pattern, nor made by any original, but the good-looking and will of him that makes the combination. If indeed one would conform his ideas to those which are formed by another person, they may be wrong or inadequate, because they agree not to that which the mind designs to be their archetype and pattern; in which respect only any ideas of modes can be wrong, imperfect, or inadequate.

148. Thirdly, Our ideas of substances have in the mind a double reference: First, They are sometimes referred to a supposed real essence, of each species of things; secondly, They are designed for representations in the mind, of things that do exist, by ideas discoverable in them: in both which respects they are inadequate.

149. First, If the names of substances stand for things, as supposed to have certain real essences, whereby they are of this or that species, of which real essences men are wholly ignorant; it follows, that the ideas they have in their minds, being referred to real essences as archetypes which are unknown, they may be so far from being adequate, that they cannot be supposed to be any representation of them at all. Our complex ideas of substances are nothing but certain collections of simple ideas that have been observed or supposed constantly to exist together. But such a complex idea cannot be the real essence of any substance: for then the properties we discover in it would be deducible from it, and their necessary connection with it be known; as all the properties of a triangle depend on and are deducible from the complex idea of three lines including a space: but it is certain, that in our complex ideas of substances are not contained such ideas on which all other qualities that are to be found in them depend.

150. Secondly, Those that take their ideas of substances from their sensible qualities, cannot form adequate ideas of them: because their qualities and



True and  
False Ideas.

powers are so various, that no man's complex *idea* can contain them all. Most of our simple *ideas*, whereof our complex ones of substances do consist, are powers, which being relations to other substances, we cannot be sure we know all the powers, till we have tried what changes they are fitted to give and receive from other substances in their several ways of application; which being not possible to be tried upon one body, much less upon all, it is impossible we should have adequate *ideas* of any substance made of a collection of all its properties.

## SECT. XXVII. Of True and False Ideas.

151. Truth and falsehood, in propriety of speech, belong only to propositions; and when *ideas* are termed true or false, there is some secret or tacit proposition which is the foundation of that denomination. Our *ideas* being nothing but appearances or perceptions in the mind, can, in strictness of speech, no more be said to be true or false than single names of things can be said to be true or false. The *idea* of Centaur has no more falsehood in it when it appears in our minds, than the name Centaur when it is pronounced or writ on paper. For truth or falsehood lying always in some affirmation or negation, our *ideas* are not capable, any of them, of being false, till the mind passes some judgement on them, that is, affirms or denies something of them. In a metaphysical sense they may be said to be true, that is, to be really such as they exist; tho' in things called true, even in that sense, there is perhaps a secret reference to our *ideas*, looked upon as the standards of that truth; which amounts to a mental proposition.

152. When the mind refers any of its *ideas* to any thing extraneous to it, they are then capable of being true or false: because in such a reference, the mind makes a tacit supposition of their conformity to that thing; which supposition, as it is true or false, so the *ideas* themselves come to be denominated. This happens in these cases:

1st, When the mind supposes its *idea* conformable to that in other mens minds called by the same name, such as that of justice, virtue, &c.

2dly, When the mind supposes any *idea* conformable to some real existence. Thus, that of Man is true, that of Centaur false; the one having a conformity to what has really existed, the other not.

3dly, When the mind refers any of its *ideas* to that real constitution and essence of any thing whereon all its properties depend: and thus the greatest part, if not all our *ideas* of substances, are false.

153. As to the first, when we judge of our *ideas* by their conformity to those of other men, they may be any of them false: but simple *ideas* are least liable to be so mistaken. We seldom mistake green for blue, or bitter for sweet; much less do we confound the names belonging to different senses, and call a colour by the name of a taste. Complex *ideas* are much more liable to falsehood in this particular; and those of mixed modes more than substances: because, in substances, their sensible qualities serve, for the most part, to distinguish them clearly; but in mixed modes we are more uncertain, and we may call that justice which ought to be called by another name. The reason of this is, that the abstract *ideas* of mixed modes being

True and  
False Ideas.

mens voluntary combination of such a precise collection of simple *ideas*, we have nothing else to refer our *ideas* of mixed modes or standards to, but the *ideas* of those who are thought to use names in their proper significations; and so as our *ideas* conform or differ from them, they pass for true or false.

154. As to the second, When we refer our *ideas* to the real existence of things, none can be termed false but our complex *ideas* of substances: for our simple *ideas* being nothing but perceptions in us answerable to certain powers in external objects, their truth consists in nothing but such appearances as are produced in us suitable to those powers: neither do they become liable to the imputation of falsehood, whether we judge these *ideas* to be in the things themselves, or no: for God having set them as marks of distinguishing things, that we may be able to discern one thing from another, and thereby choose them as we have occasion, it alters not the nature of our simple *ideas*, whether we think the *idea* of blue (for instance) to be in the violet itself, or in the mind only: and it is equally from that appearance to be denominated blue, whether it be that real colour, or only a peculiar texture in it, that causes in us that *idea*; since the name blue notes properly nothing but that mark of distinction that is in a violet, discernible only by our eyes, whatever it consists in.

155. Neither would our simple *ideas* be false, if by the different structure of our organs it were so ordered that the same object should produce in several mens minds different *ideas*: for this could never be known, since objects would operate constantly after the same manner. It is most probable, nevertheless, that the *ideas* produced by the same objects in different mens minds are very near and undiscernibly like. Names of simple *ideas* may be misapplied; as a man, ignorant in the English tongue, may call purple, scarlet: but this makes no falsehood in the *idea*.

156. Complex *ideas* of modes cannot be false, in reference to the essence of any thing really existing; because they have no reference to any pattern existing, or made by nature.

157. Our complex *ideas* of substances, being all referred to patterns in things themselves, may be false. They are so, 1st, When looked upon as representations of the unknown essences of things: 2dly, When they put together simple *ideas* which in the real existence of things have no union; as in Centaur. 3dly, When from any collection of simple *ideas*, that do not always exist together, there is separated, by a direct negation, any one simple *idea* which is constantly joined with them. Thus, if from extension, solidity, fixedness, malleableness, fusibility, &c. we remove the colour observed in gold: if this *idea* is only left out of the complex one of gold, it is to be looked on as an inadequate and imperfect, rather than a false one; since though it contains not all the simple *ideas* that are united in nature, yet it puts none together but what do really exist together.

158. Upon the whole, our *ideas*, as they are considered by the mind, either in reference to the proper signification of their names, or in reference to the reality of things, may more properly be called right or wrong *ideas*, according as they agree or disagree to those patterns to which they are referred. The *ideas* that are in mens minds, simply considered, cannot be wrong

Association  
of Ideas.

wrong, unless *complex ideas*, wherein inconsistent parts are jumbled together. All other *ideas* are in themselves right, and the knowledge about them right and true knowledge. But when we come to refer them to any patterns, or archetypes, then they are capable of being wrong, as far as they disagree with such archetypes.

SECT. XXVIII. *Of the Association of Ideas.*

159. SOME OF OUR *ideas* have a natural correspondence and connection one with another: it is the office and excellency of our reason to trace these, and hold them together in that union and correspondence which is founded in their peculiar beings. Besides this, there is another connection of *ideas* wholly owing to chance or custom: *ideas* that in themselves are not at all of kin, come to be so united in some mens minds, that it is very hard to separate them; they always keep company, and the one no sooner comes into the understanding, but its associate appears with it; and if they are more than two, the whole gang always inseparably shew themselves together. This strong combination of *ideas*, not allied by nature, the mind makes in itself either voluntarily or by chance: and hence it comes in different men to be very different, according to their different *inclinations, educations, interests, &c.* Custom settles habits of thinking in the understanding, as well as of determining in the will, and of motions in the body; all which seem to be but trains of motion in the animal-spirits, which, once set a-going, continue on in the same steps they have been used to; which by often treading are worn into a smooth path, and the motion in it becomes easy, and, as it were, natural. As far as we can comprehend thinking, thus *ideas* seem to be produced in our minds; or if they are not, this may serve to explain their following one another in an habitual train, when once they are put into that tract, as well as it does to explain such motions of the body.

160. This connection in our minds of *ideas*, in themselves loose and independent one of another, is of so great force to set us awry in our actions, as well moral as natural, passions, reasonings, and notions themselves, that perhaps there is not any one thing that deserves more to be looked after. Thus the *ideas of goblins and sprites* have really no more to do with darkness than light; yet let but a foolish maid inculcate these often on the mind of a child, and raise them there together, possibly he shall never be able to separate them again so long as he lives, but darkness shall ever afterwards bring with it those frightful *ideas*. A man has suffered pain or sickness in any place; he saw his friend die in such a room; though these have in nature nothing to do one with another, yet when the *idea* of the place occurs to his mind, it brings that of the pain and displeasure with it; he confounds him in his mind, and can as little bear the one as the other.

161. *Intellectual habits* and defects this way contracted, are not less frequent and powerful, though less observed. Let the *ideas of being and matter* be strongly joined either by education or much thought, whilst these are still combined in the mind, what notions, what reasonings will there be about separate spirits? Let custom from the very childhood have joined figure and shape to the *idea* of God, and what absurdities

will that mind be liable to about the Deity? Let the *idea of infallibility* be joined to any person, and these two constantly together possess the mind; and then one body in two places at once shall be fallowed for a certain truth, whenever that imagined infallible person dictates, and demands assent without inquiry.

162. Some such wrong combinations of *ideas* will be found to establish the irreconcilable opposition between different sects of philosophy and religion: for we cannot imagine every one of their followers to impose wilfully on himself, and knowingly refuse truth offered by plain reason. Interest, though it does a great deal in the case, yet cannot be thought to work whole societies of men to so universal a perverseness, as that every one of them should knowingly maintain falsehood; some at least must be allowed to do what all pretend to, i. e. to pursue truth sincerely. That therefore which captivates their reasons, and leads men of sincerity blindfold from common sense, will, when examined, be found to be what we are speaking of: some independent *ideas* are by education, custom, and the constant din of their party, so coupled in their minds, that they always appear there together; and they can no more separate them in their thoughts, than if they were but one *idea*; and they operate as if they were so. This gives sense to jargon, demonstration to absurdities, and consistency to nonsense, and is the foundation of the greatest errors in the world. The confusion of two different *ideas*, which a customary connection of them in their minds hath to them in effect made but one, cannot but fill mens heads with false views, and their reasonings with false consequences.

SECT. XXIX. *Of Knowledge in general.*

163. SINCE the mind, in all its thoughts and reasonings, has no other immediate object but its own *ideas*, which alone it does or can contemplate, it is evident that our knowledge is only conversant about them. *Knowledge* then seems to be nothing but the perception of the connection and agreement, or disagreement and repugnancy of any of our *ideas*: where this perception is, there is *knowledge*; and where it is not, there, though we fancy, guess, or believe, yet we always come short of *knowledge*. When we know that *white* is not *black*, what do we but perceive that these two *ideas* do not agree? Or that the three angles of a *triangle*, are equal to two right ones; what do we more but perceive that equality to two right ones does necessarily agree to and is inseparable from the three angles of a triangle? But to understand a little more distinctly wherein this agreement or disagreement consists, we may reduce it all to these four sorts: 1<sup>st</sup>, *Identity* or *diversity*; 2<sup>dy</sup>, *Relation*; 3<sup>dy</sup>, *Co-existence*; 4<sup>thly</sup>, *Real existence*.

164. I. *Identity* or *diversity*. It is the first act of the mind to perceive its *ideas*; and, so far as it perceives them, to know each what it is, and thereby to perceive their difference, that is, the one not to be the other: by this the mind clearly perceives each *idea* to agree with itself, and to be what it is; and all distinct *ideas* to disagree. This it does without any pains or deduction, by its natural power of perception and distinction. This is what men of art have reduced to those general rules, viz. *What is, is; and, It is impossible for the same thing to be and not to be.* But no maxim

Knowledge  
in general.

*Knowledge.* *maxim* can make a man know it clearer, that *round* is not *square*, than the bare perception of those two *ideas*, which the mind at first sight perceives to disagree.

165. II. The next sort of agreement or disagreement the mind perceives in any of its *ideas* may be called *relative*, and is nothing but the perception of the relation between any two *ideas* of what kind soever; that is, their agreement or disagreement one with another in several ways the mind takes of comparing them.

166. III. The third sort of agreement or disagreement to be found in our *ideas*, is, *coexistence* or *non-existence* in the same subject; and this belongs particularly to substances. Thus when we pronounce concerning *gold*, that it is fixed; it amounts to no more but this, that fixedness, or a power to remain in the fire unconsumed, is an *idea* that always accompanies that particular sort of *yellowness*, *weight*, *fixibility*, &c. which make our complex *idea* signified by the word *gold*.

167. IV. The fourth sort is that of actual and real existence agreeing to any *idea*. Within these four sorts of agreement or disagreement, is contained all the knowledge we have, or are capable of. For all that we know or can affirm concerning any *idea*, is, That it is, or is not, the same with some other; as, that *blue* is not *yellow*: That it does, or does not, coexist with another in the same subject; as, that *iron* is susceptible of *magnetical impressions*: That it has that or this relation to some other *ideas*; as, that two *triangles*, upon equal bases upon two parallels, are equal: or, That it has a real existence without the mind; as, that *God* is.

168. There are several ways wherein the mind is possessed of truth, each of which is called *knowledge*. First, There is *actual knowledge*, when the mind has a present view of the agreement or disagreement of any of its *ideas*, or of the relation they have one with another. Secondly, A man is said to know any proposition, when having once evidently perceived the agreement or disagreement of the *ideas* whereof it consists, and so lodged it in his memory, that whenever it comes to be reflected on again, the mind assents to it without doubt or hesitation, and is certain of the truth of it. And this may be called *habitual knowledge*. And thus a man may be said to know all those truths which are lodged in his memory by a foregoing, clear, and full perception.

169. Of *habitual knowledge* there are two sorts: the one is of such truths laid up in the memory, as whenever they occur to the mind, it actually perceives the relation that is between those *ideas*. And this is in all those truths, where the *ideas* themselves, by an immediate view, discover their agreement or disagreement one with another. The other is of such truths, whereof the mind having been convinced, it retains the memory of the conviction, without the proof. Thus a man that remembers certainly, that he once perceived the demonstration, that the three angles of a triangle are equal to two right ones, knows it to be true, when that demonstration is gone out of his mind, and possibly cannot be recollected: but he knows it in a different way from what he did before, namely, not by the intervention of those intermediate *ideas*, whereby the agreement or disagreement of those in the proposition was at first perceived, but by remembering, i. e. know-

ing that he was once certain of the truth of this proposition, that the three angles of a triangle are equal to two right ones. The immutability of the same relations between the same immutable things, is now the *idea* that shews him, that if the three angles of a triangle were once equal to two right ones, they will always be so. And hence he comes to be certain, that what was once true, is always true; what *ideas* once agreed, will always agree; and consequently, what he once knew to be true, he will always know to be true, as long as he can remember that he once knew it.

SECT. XXX. Of the Degrees of our Knowledge.

170. ALL our knowledge consisting in the view the mind has of its own *ideas*, which is the utmost light and greatest certainty we are capable of, the different clearness of our knowledge seems to lie in the different way of perception the mind has of the agreement or disagreement of any of its *ideas*.

171. When the mind perceives this agreement or disagreement of two *ideas* immediately by themselves, without the intervention of any other, we may call it *intuitive knowledge*; in which cases the mind perceives truth, as the eye does light, only by being directed towards it. Thus the mind perceives, that *white* is not *black*; that *three* are more than *two*, and equal to *one* and *two*. This part of knowledge is irrefragable, and, like the bright sunshine, forces itself immediately to be perceived as soon as ever the mind turns its view that way. It is on this intuition that depends all the certainty and evidence of our other knowledge; which certainly every one finds to be so great, that he cannot imagine, and therefore not require a greater.

172. The next degree of knowledge is, where the mind perceives not this agreement or disagreement immediately, or by the *juxta-position*, as it were, of the *ideas*, because those *ideas* concerning whose agreement or disagreement the inquiry is made, cannot by the mind be so put together as to shew it. In this case the mind is fond to discover the agreement or disagreement which it searches, by the intervention of other *ideas*: And this is that which we call *reasoning*. And thus, if we would know the agreement or disagreement in bigness between the three angles of a triangle and two right angles, we cannot by an immediate view and comparing them do it; because the three angles of a triangle cannot be brought at once, and be compared with any other one or two angles. And so of this the mind has no immediate or intuitive knowledge. But we must find out some other angles to which the three angles of a triangle have equality; and finding those equal to two right ones, we come to know the equality of these three angles to two right ones. These intervening *ideas* which serve to shew the agreement of any two others, are called *proofs*; and where the agreement or disagreement is by this means plainly and clearly perceived, it is called *demonstration*. A quickness in the mind to find those proofs, and to apply them right, is that which is called *sagacity*.

173. This knowledge, though it be certain, is not so clear and evident as *intuitive knowledge*. It requires pains and attention, and steady application of mind, to discover the agreement or disagreement of the *ideas* it considers; and there must be a progression by steps and degrees before the mind can in this way

Degrees of  
Knowledge.

arrive at certainty. Before demonstration there was a doubt, which, in *intuitive knowledge*, cannot happen to the mind that has its faculty of perception left to a degree capable of distinct *ideas*, no more than it can be a doubt to the eye (that can distinctly see *white* and *black*) whether this ink and paper be all of a colour.

174. Now, in every step that reason makes in *demonstrative knowledge*, there is an *intuitive knowledge* of that agreement or disagreement it seeks with the next immediate *ideas* which it uses as a proof: for if it were not so, that yet would need a proof: since without the perception of such agreement or disagreement, there is no knowledge produced. By which it is evident, that every step in reasoning that produces knowledge has *intuitive certainty*; but when the mind perceives, there is no more required but to remember it, to make the agreement or disagreement of the *ideas* concerning which we inquire visible and certain. This *intuitive perception* of the agreement or disagreement of the intermediate *ideas* in each step and progression of the demonstration, must also be exactly carried in the mind; and a man must be sure that no part is left out; which because in long deductions the memory cannot easily retain, this knowledge becomes more imperfect than *intuitive*, and men often embrace falsehoods for demonstrations.

175. It has been generally taken for granted, that mathematics alone are capable of demonstrative certainty. But to have such an agreement or disagreement as may be *intuitively* perceived, being not the privilege of the *ideas* of *number*, *extension*, and *figure* alone, it may possibly be the want of due method and application in us, and not of sufficient evidence in things, that demonstration has been thought to have so little to do in other parts of knowledge: For in whatever *ideas* the mind can perceive the agreement or disagreement immediately, there it is capable of *intuitive knowledge*: And where it can perceive the agreement or disagreement of any two *ideas* by an *intuitive perception* of the agreement or disagreement they have with any intermediate *ideas*, there the mind is capable of demonstration which is not limited to the *ideas* of *figure*, *number*, *extension*, or their modes. The reason why it has been generally supposed to belong to them only, is because in comparing their equality or excess the *modes* of *numbers* have every the least difference very clear and perceivable: And in *extension*, though every the least excess is not so perceptible, yet the mind has found out ways to discover the just equality of two angles, extensions, or figures; and both, that is, numbers and figures, can be set down by visible and lasting marks.

176. But in other simple *ideas*, whose modes and differences are made and counted by degrees, and not quantity, we have not so nice and accurate a distinction of their differences as to perceive or find ways to measure their just equality or the least differences: for those other simple *ideas* being appearances or sensations produced in us by the *size*, *figure*, *motion*, &c. of minute corpuscles singly insensible, their different degrees also depend on the variation of some or all of those causes; which since it cannot be observed by us in particles of matter, whereof each is too subtle to be perceived, it is impossible for us to have any exact mea-

asures of the different degrees of these simple *ideas*. Thus, for instance, not knowing what number of particles, nor what motion of them, is fit to produce any precise degree of *whiteness*, we cannot demonstrate the certain equality of any two degrees of *whiteness*, because we have no certain standard to measure them by, nor means to distinguish every the least difference; the only help we have being from our senses, which in this point fail us.

177. But where the difference is so great as to produce in the mind *ideas* clearly distinct, there *ideas*, of colours, as we see in different kinds, (*blue* and *red*, for instance), are as capable of demonstration as *ideas* of number and extension. What is here said of colours holds true in all secondary qualities. These two then, *intuition* and *demonstration*, are the degrees of our knowledge; whatever comes short of one of these is but *faith* or *opinion*, not *knowledge*, at least in all general truths. There is indeed another perception of the mind employed about the particular existence of finite beings without us; which going beyond probability, but not reaching to either of the foregoing degrees of certainty, passes under the name of *knowledge*.

178. Nothing can be more certain than that the *idea* we receive from an external object is in our minds: This is *intuitive knowledge*; but whether we can thence certainly infer the existence of any thing without us corresponding to that *idea*, is that whereof some men think there may be a question made, because men may have such an *idea* in their minds when no such things exist, no such object affects their senses. But it is evident that we are invincibly conscious to ourselves of a different perception, when we look upon the sun in the day, and think on it by night; when we actually taste wormwood or smell a rose, or only think on that savour or odour. So that we may add to the two former sorts of knowledge this also of the existence of particular external objects, by that perception and consciousness we have of the actual entrance of *ideas* from them, and allow these three degrees of knowledge, viz. *intuitive*, *demonstrative*, and *sensitive*.

179. But since our knowledge is founded on and employed about our *ideas* only, will it follow thence that it must be conformable to our *ideas*; and that where our *ideas* are clear and distinct, obscure and confused, there our knowledge will be too? No. For our knowledge consisting in the perception of the agreement or disagreement of any two *ideas*, its clearness or obscurity consists in the clearness or obscurity of that perception, and not in the clearness or obscurity of the *ideas* themselves. A man (for instance) that has a clear *idea* of the angles of a triangle, and of equality to two right ones, may yet have but an obscure perception of their agreement; and so have but a very obscure knowledge of it. But obscure and confused *ideas* can never produce any clear or distinct knowledge; because, as far as any *ideas* are obscure or confused, so far the mind can never perceive clearly whether they agree or disagree.

SECT. XXXI. *Of the Extent of Human Knowledge.*

180. FROM what has been said concerning knowledge, it follows, First, That we can have no know-  
ledge

Extent of  
Knowledge.

ledge farther than we have *ideas*.

Secondly, That we have no knowledge farther than we can have perception of that agreement or disagreement of our *ideas*, either by *intuition, demonstration, or sensation*.

Thirdly, We cannot have an *intuitive* knowledge that shall extend itself to all our *ideas*, and all that we would know about them, because we cannot examine and perceive all the relations they have one to another by *juxta-position*, or an immediate comparison one with another. Thus we cannot *intuitively* perceive the equality of two extensions, the difference of whose figures makes their parts incapable of an exact immediate application.

Fourthly, Our *rational* knowledge cannot reach to the whole extent of our *ideas*; because between two different *ideas* we would examine, we cannot always find such *proofs* as we can connect one to another, with an *intuitive knowledge* in all the parts of the deduction.

Fifthly, *Sensitive* knowledge reaching no farther than the existence of things actually present to our senses, is yet much narrower than either of the former.

Sixthly, From all which it is evident, that the extent of our *knowledge* comes not only short of the reality of things, but even of the extent of our own *ideas*. We have the *ideas* of a *square*, a *circle*, and *equality*; and yet perhaps shall never be able to find a *circle equal to a square*.

181. The affirmations or negations we make concerning the *ideas* we have, being reduced to the four sorts above-mentioned, *viz. identity, coexistence, relation, and real existence*, we shall examine how far our knowledge extends in each of these.

182. First, As to *identity and diversity*, our *intuitive knowledge* is as far extended as our *ideas* themselves; and there can be no *idea* in the mind which it does not presently, by an *intuitive knowledge*, perceive to be what it is, and to be different from any other.

183. Secondly, As to the agreement or disagreement of our *ideas* in *coexistence*: in this our knowledge is very short; tho' in this consists the greatest and most material part of our knowledge, concerning *substances*. For our *ideas* of *substances* being nothing but certain *collections of simple ideas, coexisting in one subject*, (our *idea* of *flame*, for instance, is a body *hot, luminous, and moving upward*; when we would know any thing farther concerning this, or any other sort of substance, what do we do but inquire what other qualities or powers these substances have, or have not? Which is nothing else but to know what other simple *ideas* do or do not *coexist* with those that make up that complex *idea*. The reason of this is, because the simple *ideas* which make up our complex *ideas* of substances, have no visible necessary connection or inconsistency with other simple *ideas* whose coexistence with them we would inform ourselves about. These *ideas* being likewise, for the most part, *secondary qualities*, which depend upon the *primary* qualities of their minute or insensible parts, or on something yet more remote from our comprehension, it is impossible we should know which have a necessary union or inconsistency one with another, since we know not the root from whence they spring, or the size, figure, and texture of parts on which they depend, and from which

they result.

184. Besides this, there is no *discoverable connection* between any *secondary* quality, and those *primary* qualities that it depends on. We are so far from knowing what figure, size, or motion produces (for instance) a *yellow colour*, or *sweet taste*, or a *sharp sound*, that we can by no means conceive how any *size, figure, or motion*, can possibly produce in us the *idea* of any *colour, taste, or sound*, whatsoever; and there is no conceivable connection between the one and the other.

185. Our knowledge therefore of coexistence reaches little farther than *experience*. Some few, indeed, of the *primary* qualities have a necessary dependence and visible connection one with another; as *figure* necessarily supposes *extension, receiving or communicating motion by impulse* supposes *solidity*. But qualities co-existent in any subject, without this dependence and connection, cannot certainly be known to coexist any farther than experience by our senses informs us. Thus, though upon trial we find *gold* yellow, weighty, malleable, fusible, and fixed, yet because none of these have any evident dependence or necessary connection with the other, we cannot certainly know that where any four of these are, the *fifth* will be there also, how highly probable soever it may be: but the highest degree of *probability* amounts not to *certainty*; without which there can be no true knowledge: for this coexistence can be no further known, than it is perceived; and it cannot be perceived, but either, in *particular* subjects, by the observation of our senses, or, in *general*, by the necessary connection of the *ideas* themselves.

186. As to *incompatibility, or repugnancy to coexistence*, we may know, that any subject can have of each sort of *primary* qualities but one particular at once, one extension, one figure; and so of sensible *ideas*, peculiar to each sense: for whatever of each kind is present in any subject, excludes all others of that sort; for instance, one subject cannot have *two smells* or *two colours* at the same time.

187. As to *powers of substances*, which make a great part of our inquiries about them, and are no inconsiderable branch of our knowledge; our knowledge as to these reaches little farther than *experience*, because they consist in a texture and motion of parts which we cannot by any means come to discover. *Experience* is that which in this part we must depend on; and it were to be wished that it were more improved.

188. As to the third sort, the *agreement or disagreement of our ideas in any other relation*, this is the largest field of knowledge, and it is hard to determine how far it may extend. This part depending on our sagacity in finding intermediate *ideas* that may shew the habitudes and relations of *ideas*, it is an hard matter to tell when we are at the end of such discoveries. They that are ignorant of *algebra*, cannot imagine the wonders in this kind that are to be done by it; and what further improvements and helps advantageous to other parts of knowledge the sagacious mind of man may yet find out, it is not easy to determine. The *ideas* of *quantity* are not those alone that are capable of demonstration and knowledge; other, and perhaps more useful parts of contemplation, would un-

Extent of  
Knowledge

doubtedly afford us certainty, if vices, passions, and domineering interest, did not oppose or menace endeavours of this kind.

189. The idea of a *Supreme Being*, infinite in power, goodness, and wisdom, whose workmanship we are, and on whom we depend; and *ideas of ourselves*, as understanding rational creatures; would, if duly considered, afford such foundation of our *duty*, and *rules of action*, as might place *morality* among the sciences capable of demonstration. The relations of other modes may certainly be perceived, as well as those of number and extension. *Where there is no property, there is no injustice*, is a proposition as certain as any demonstration in Euclid: for the *idea of property* being a right to any thing; and the *idea of injustice* being the invasion or violation of that right; it is evident, that these *ideas* being thus established, and these names annexed to them, we can as certainly know this proposition to be true, as that a *triangle has three angles equal to two right ones*. Again, *No government allows absolute liberty*. The *idea of government* being the establishment of society upon certain rules or laws which require conformity to them, and the *idea of absolute liberty* being for any one to do whatever he pleases, we are as capable of being certain of the truth of this proposition as of any in *mathematics*.

190. What has given the advantage to the *ideas of quality*, and made them thought more capable of certainty and demonstration, is,

191. First, That they can be represented by sensible marks, which have a nearer correspondence with them than any words or sounds. *Diagrams* drawn on paper are copies of the *ideas*, and not liable to the uncertainty that words carry in their signification: but we have no sensible marks that resemble our *moral ideas*, and nothing but words to express them by; which though when written they remain the same, yet the *ideas* they stand for may change in the same man; and it is very seldom that they are not different in different persons.

192. Secondly, *Moral ideas* are commonly more complex than figures. Whence these two inconveniences follow: 1. That their names are of more uncertain signification; the precise collection of simple *ideas* they stand for not being so easily agreed on, and so the sign that is used for them, in communication always, and in thinking often, does not steadily carry with it the same *idea*. 2. The mind cannot easily retain those precise combinations so exactly and perfectly as is necessary, in the examination of the habits and correspondencies, agreements or disagreements, of several of them one with another, especially where it is to be judged of by long deductions, and the intervention of several other complex *ideas*; to shew the agreement or disagreement of two remote ones.

193. Now one part of these disadvantages in *moral ideas*, which has made them to be thought not capable of demonstration, may in a good measure be remedied by *definitions*, setting down that collection of simple *ideas* which every term shall stand for, and then using the terms steadily and constantly for that precise collection.

194. As to the fourth sort of knowledge, viz. of the *real actual existence of things*, we have an *intuitive knowledge of our own existence*; a *demonstrative*

knowledge of the *existence of God*; and a *sensitive* Causes of knowledge of the *objects that present themselves to our* Ignorance. *sense*.

195. From what has been said, we may discover the *causes of our ignorance*, which are chiefly these three: First, *Want of ideas*: Secondly, *Want of a discoverable connection between the ideas we have*: Thirdly, *Want of tracing and examining our ideas*.

196. First, There are some things we are ignorant of for *want of ideas*. All the simple *ideas* we have are confined to the observations of our senses, and the operations of our own minds that we are conscious of in ourselves. What other *ideas* it is possible other creatures may have by the assistance of other senses and faculties more or perfecter than we have, or different from ours, it is not for us to determine; but to say or think there is no such, because we conceive nothing of them, is no better an argument, than if a blind man should be positive in it, that there was no such thing as sight and colours, because he had no manner of *idea* of any such thing. What faculties therefore other species of creatures have to penetrate into the nature and inmost constitutions of things, we know not. This we know, and certainly find, that we want other views of them, besides those we have, to make discoveries of them more perfect. The *intellectual and sensible world* are in this perfectly alike, that the parts which we see of either of them hold no proportion with that we see not, and whatsoever we can reach with our eyes or our thoughts of either of them is but a point almost nothing in comparison of the rest.

197. Another great cause of ignorance, is the *want of ideas that we are capable of*. This keeps us in ignorance of things we conceive capable of being known. Bulk, figure, and motion, we have *ideas* of; yet not knowing what is the particular bulk, motion, and figure, of the greatest part of the bodies of the universe, we are ignorant of the several powers, efficacies, and ways of operation, whereby the effects we daily see are produced. These are hid from us, in some things, by being *too remote*; in others, by being *too minute*.

198. When we consider the vast distance of the known and visible parts of the world, and the reasons we have to think that what lies within our ken is but a small part of the immense universe, we shall then discover an huge abyss of ignorance. What are the particular fabrics of the great masses of matter which make up the whole stupendous frame of corporeal beings; how far they are extended; what is their motion, and how continued; and what influence they have upon one another; are contemplations, that at first glimpse our thoughts lose themselves in. If we confine our thoughts to this little system of our sun, and the grosser masses of matter that visibly move about it; what several sorts of vegetables, animals, and intellectual corporeal beings, infinitely different from those of our little spot of earth, may probably be in other *planets*; to the knowledge of which, even of their outward figures and parts, we can no way attain whilst we are confined to this earth, there being no natural means, either by sensation or reflection, to convey their certain *ideas* into our minds?

199. There are other bodies in the universe, no less con-

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Causes of Ignorance.

concealed from us by their *minuteness*. These insensible corpuscles being the active parts of matter, and the great instruments of nature on which depend all their *secondary* qualities and operations, our want of precise distinct *ideas* of their *primary* qualities keeps us in incurable ignorance of what we desire to know about them. Did we know the mechanical affections of *rhubarb* and *opium*, we might as easily account for their operations of *purging* or *causing sleep*, as a watchmaker can for the motions of his watch. The dissolving of silver in *aqua fortis*, or gold in *aqua regia*, and not vice versa, would be then, perhaps, no more difficult to know, than it is to a smith to understand why the turning of one key will open a lock, and not the turning of another. But whilst we are destitute of senses acute enough to discover the minute particles of bodies, and to give us *ideas* of their mechanical affections, we must be content to be ignorant of their properties and operations: nor can we be assured about them any farther than some few trials we make are able to reach; but whether they will succeed again another time, we cannot be certain. This hinders our certain knowledge of universal truths concerning natural bodies; and our reason carries us herein very little beyond particular matters of fact. And therefore, how far soever human industry may advance useful and *experimental philosophy* in physical things, yet *scientific* will still be out of our reach; because we want perfect and adequate *ideas* of those very bodies which are nearest to us, and most under our command.

200. This, at first sight, shews us how disproportionate our knowledge is to the whole extent, even of *material* beings; to which if we add the consideration of that infinite number of *spirits* that may be, and probably are, which are yet more remote from our knowledge, whereof we have no cognizance; we shall find this cause of ignorance conceal from us, in an impenetrable obscurity, almost the whole *intellectual* world, a greater, certainly, and a more beautiful world than the *material*: for bating some very few *ideas* of spirit we get from our own mind by reflection, and from thence the best we can collect of the *Father of all spirits*, the Author of them and us all things, we have no certain information so much as of the existence of other spirits but by revelation; much less have we distinct *ideas* of their different natures, states, powers, and several constitutions, wherein they agree or differ one from another, and from us; and therefore in what concerns their different species and properties, we are under an absolute ignorance.

201. The second cause of ignorance, is the want of discoverable connection between those *ideas* we have: where we want that, we are utterly incapable of *universal* and certain knowledge: and are, in the former case, left only to *observation* and *experiment*. Thus the mechanical affections of bodies having no affinity at all with the *ideas* they produce in us, we can have no distinct knowledge of such operations beyond our experience; and can reason no otherwise about them, than as the effects or appointment of an infinitely wise agent, which perfectly surpasses our comprehensions.

202. The operation of our minds upon our bodies is as inconceivable. How any *thought* should produce a motion in *body*, is as remote from the na-

ture of our *ideas*, as how any *body* should produce any *thought* in the *mind*. That it is so, if experience did not convince us, the consideration of the things themselves would never be able in the least to discover to us.

203. In some of our *ideas* there are certain relations, habitudes, and connections, so visibly included in the nature of the *ideas* of themselves, that we cannot conceive them separable from them by any power whatsoever: in these only we are capable of certain and universal knowledge. Thus the *idea* of a *right-lined triangle*, necessarily carries with it an equality of its angles to two right ones. But the coherence and continuity of the parts of matter, the production of sensation in us of *colours* and *sounds*, &c. by impulse and motion, being such wherein we can discover no natural connection with any *ideas* we have, we cannot but ascribe them to the arbitrary will and good pleasure of the wise Architect.

204. The things that we observe constantly to proceed regularly, we may conclude to act by a law set them; but yet by a law that we know not; whereby, tho' causes work steadily, and effects constantly flow from them, yet their connections and dependencies being not discoverable in our *ideas*, we can have but an experimental knowledge of them.

205. The third cause of ignorance, is our want of tracing those *ideas* we have or may have, and finding out those intermediate *ideas* which may shew us what habitude of agreement or disagreement they may have one with another: and thus many are ignorant of *mathematical* truths, for want of application in inquiring, examining, and by due ways comparing those *ideas*.

206. Hitherto we have examined the extent of our knowledge in respect of the several sorts of beings that are: there is another extent of it, in respect of *universality*, which will also deserve to be considered; and in this regard our knowledge follows the nature of our *ideas*. If the *ideas* are *abstract*, whose agreement or disagreement we perceive, our knowledge is *universal*. For what is known of such general *ideas*, will be true of every particular thing in which that essence, that is, *abstract idea*, is to be found: and what is once known of such *ideas*, will be perpetually and for ever true. So that, as to all general knowledge, we must search and find it only in our own minds: and it is only the examining of our own *ideas* that furnishes us with that. Truths belonging to essences of things, (that is, to *abstract ideas*), are *eternal*, and are to be found out by the contemplation only of those essences, as the existence of things is to be known only from experience.

## SECT. XXXII. Of the Reality of our Knowledge.

207. THE reader by this time may be ready to object, If it be true, that all knowledge lies only in the perception of the agreement or disagreement of our own *ideas*, the visions of an *enthusiast*, and the reasonings of a *fiber* man, will be equally certain: it is no matter how things are, so a man observe but the agreement of his own imaginations, and talk conformably; it is all truth, all certainty.

208. To this it is answered, That if our knowledge of our *ideas* should terminate in them, and reach no farther,

Reality of Knowledge.



farther, when there is something farther intended, our most serious thoughts would be of little more use than the *reveries* of a crazy brain. But it is evident, that this way of *certainty*, by the knowledge of our own *ideas*, goes a little farther than bare imagination; and that all the certainty of general truths a man has, lies in nothing else but this knowledge of our *ideas*.

209. It is evident, that the mind knows not things immediately, but by the intervention of the *ideas* it has of them. Our knowledge therefore is *real*, only so far as there is a conformity between our *ideas* and the reality of things. But how shall we know when our *ideas* agree with things themselves? There are *two sorts of ideas*, that we may be assured agree with things: these are,

210. First, *Simple ideas*; which since the mind can by no means make to itself, must be the effect of things operating upon the mind in a natural way, and producing therein those perceptions, which, by the will of our Maker, they are ordained and adapted to. Hence it follows, that *simple ideas* are not fictions of our fancies, but the natural and regular productions of things without us, really operating upon us; which carry with them all the conformity our state requires, which is to represent things under those appearances they are fitted to produce in us. Thus the *idea of whiteness*, as it is in the mind, exactly answers that power which is in any body to produce it there. And this conformity between our *simple ideas*, and the existence of things, is sufficient for real knowledge.

211. Secondly, All our *complex ideas*, except those of substances, being *archetypes* of the mind's own making, and not referred to the existence of things as to their originals, cannot want any conformity necessary to real knowledge: for that which is not designed to represent any thing but itself, can never be capable of a wrong representation. Here the *ideas* themselves are considered as *archetypes*, and things no otherwise regarded than as they are conformable to them. Thus the mathematician considers the truth and properties belonging to a *rectangle* or *circle* only as they are *ideas* in his own mind, which possibly he never found existing mathematically, that is, precisely true: yet his knowledge is not only certain, but *real*; because real things are no farther concerned, nor intended to be meant by any such propositions, than as things really agree to those *archetypes* in his mind. It is true of the *idea of a triangle*, that *its three angles are equal to two right ones*: it is true also of a *triangle*, wherever it exists: what is true of those *figures* that have barely an *ideal* existence in his mind, will hold true of them also when they come to have a *real* existence in matter.

212. Hence it follows, that *moral* knowledge is as capable of *real certainty* as *mathematics*: For *certainty* being nothing but the perception of the agreement or disagreement of our *ideas*, and demonstration nothing but the perception of such agreement by the intervention of other *ideas*; our *moral ideas*, as well as *mathematical*, being *archetypes* themselves, and so adequate or complete *ideas*, all the agreement or disagreement we shall find in them will produce *real* knowledge, as well as in *mathematical figures*. That which is requisite to make our knowledge *certain*, is the clearness of

our *ideas*; and that which is required to make it *real*, is, that they answer their *archetypes*.

213. Thirdly, But the *complex ideas*, which we refer to *archetypes* without us, may differ from them, and so our knowledge about them may come short of being *real*; and such are our *ideas of substances*. These must be taken from something that does or has existed, and not be made up *ideas* arbitrarily put together without any real pattern. Herein, therefore, is founded the reality of our knowledge concerning *substances*, that all our *complex ideas* of them must be such, and such only, as are made up of such simple ones as have been discovered to coexist in nature. And our *ideas* being thus true, though not perhaps very exact copies, are the subjects of the *real* knowledge of them. Whatever *ideas* we have, the agreement we find they have with others will be knowledge. If those *ideas* be abstract, it will be *general* knowledge. But to make it *real* concerning *substances*, the *ideas* must be taken from the real existence of things. Wherever, therefore, we perceive the agreement or disagreement of our *ideas*, there is *certain knowledge*: and wherever we are sure those *ideas* agree with the reality of things, there is *certain real* knowledge.

#### SECT. XXXIII. Of Truth in general.

214. TRUTH, in the proper import of the word, signifies the joining or separating of signs, as the things signified by them do agree or disagree one with another. The joining or separating of signs, is what we call *propositions*: so that *truth* properly belongs only to *propositions*: whereof there are two sorts, *mental* and *verbal*; as there are *two* sorts of signs commonly made use of, *ideas* and *words*.

215. It is difficult to treat of *mental* propositions without *verbal*; because, in speaking of *mental*, we must make use of *words*, and then they become *verbal*. Again, men commonly in their thoughts and reasonings use *words* instead of *ideas*; especially if the subject of their meditation contains in it *complex ideas*. If we have occasion to form *mental* propositions about *white*, *black*, *circle*, &c. we can, and often do, frame in our minds the *ideas* themselves, without reflecting on the *names*: but when we would consider, or make propositions about the more *complex ideas*, as of a *man*, *virtu*, *fortitude*, *glory*, &c. we usually put the *name* for the *idea*; because the *idea* these *names* stand for being for the most part confused, imperfect, and undetermined, we reflect on the *names* themselves, as being more clear, certain, and distinct, and readier to occur to our thoughts, than pure *ideas*; and so we make use of these *words* instead of the *ideas* themselves, even when we would meditate and reason within ourselves, and make tacit *mental propositions*.

216. We must then observe two sorts of *propositions* that we are capable of making: First, *Mental propositions*, wherein the *ideas* in our understandings are put together or separated by the mind perceiving or judging of their agreement or disagreement. Secondly, *Verbal propositions*; which are words put together or separated in affirmative or negative sentences: so that *proposition* consists in joining or separating signs; and *truth* consists in putting together or separating these signs, according as the things they stand for agree or disagree.



Knowledge  
of  
Existence.

217. Truth, as well as knowledge, may well come under the distinction of *verbal* and *real*; that being only *verbal truth*, wherein terms are joined according to the agreement or disagreement of the *ideas* they stand for, without regarding whether our *ideas* are such as really have or are capable of having an existence in nature. But then it is they contain *real truth*, when these signs are joined as our *ideas* agree: and when our *ideas* are such as, we know, are capable of having an existence in nature; which in substances we cannot know, but by knowing that such have existed. *Truth* is the marking down in words the agreement or disagreement of *ideas* as it is; *falsehood* is the marking down in words the agreement or disagreement of *ideas* otherwise than it is: and so far as these *ideas*, thus marked by sounds, agree to their *archetypes*, so far only is the *truth real*. The knowledge of this truth consists in knowing what *ideas* the words stand for, and the perception of the agreement or disagreement of those *ideas* according as it is marked by those words.

218. Besides *truth* taken in the strict sense before mentioned, there are other sorts of *truths*: As, first, *Moral truth*: which is speaking of things according to the persuasion of our own minds. Secondly, *Metaphysical truth*; which is nothing but the real existence of things conformable to the *ideas* to which we have annexed their names.

219. These considerations of *truth* either having been before taken notice of, or not being much to our present purpose, it may suffice here only to have mentioned them.

#### SECT. XXXIV. Of our Knowledge of Existence.

220. HITHERTO we have only considered the *essences* of things; which being only *abstract ideas*, and thereby removed in our thoughts from particular existence, give us no knowledge of *existence* at all. We proceed now to inquire concerning our *knowledge of the existence* of things, and how we come by it.

221. We have the knowledge of our *own existence* by intuition; of the *existence of God*, by demonstration; and of *other things*, by sensation. As for our *own existence*, we perceive it so plainly, that it neither needs, nor is capable of any proof. *I think, I reason, I feel pleasure and pain*: can any of these be more evident to me than my *own existence*? If I doubt of all other things, that very *doubt* makes me perceive my *own existence*, and will not suffer me to doubt of that. If I know I doubt, I have as certain a perception of the *thing* doubting, as of that *thought* which I call *doubt*. Experience then convinces us, that we have an *intuitive knowledge of our own existence*, and an internal infallible perception that we *are*. In every act of sensation, reasoning, or thinking, we are conscious to ourselves of our own being; and in this matter come not short of the highest degree of certainty.

#### SECT. XXXV. Of our Knowledge of the Existence of a God.

222. THOUGH God has given us no *innate ideas* of himself, yet having furnished us with those faculties our minds are endowed with, he hath not left himself without a witness, since we have sense, perception, and reason, and cannot want a clear proof of him as long as we carry ourselves about us. Nor can we

justly complain of our ignorance in this great point, since he has so plentifully provided us with means to discover and know him, so far as is necessary to the end of our being, and the great concernment of our happiness. But though this be the most obvious truth that reason discovers, yet it requires thought and attention; and the mind must apply itself to a regular deduction of it, from some part of our *intuitive knowledge*; or else we shall be as ignorant of this, as of other propositions which are in themselves capable of clear demonstration. To shew, therefore, that we are capable of knowing, that is, *being certain*, that *there is a God*, and how we may come by this certainty, we need go no farther than ourselves, and that undoubted knowledge we have of our *own existence*. It is beyond question, that *man has a clear perception of his own being*: He knows certainly that he exists, and that he is something. In the next place, man knows by an *intuitive certainty*, that *bare nothing can no more produce any real being, than it can be equal to two right angles*. If therefore we know there is some real being, it is an evident demonstration, that *from eternity there has been something*; since what was not from eternity had a beginning, and what had a beginning must be produced by something else. Next, it is evident, that *what has its being from another, must also have all that which is in and belongs to its-being from another too*: All the powers it has, must be owing to, and received from, the same source. This eternal source then of all being must be also the source and original of all power; and so this eternal being must be also the most powerful.

223. Again, man finds in himself *perception and knowledge*: We are certain, then, that there is not only some being, but some knowing intelligent being in the world. There was a time, then, when there was no knowing being, or else there has been a knowing being from eternity. If it be said, there was a time when that eternal being had no knowledge; the reply is, that then it is impossible there should have ever been any knowledge; it being as impossible that things wholly void of knowledge, and operating blindly and without any perception, should produce a knowing being, as it is that a triangle should make itself three angles bigger than two right ones.

224. This from the consideration of ourselves, and what we infallibly find in our own constitutions, our reason leads us to the knowledge of this certain and evident truth, that *there is an eternal, most powerful and knowing being*; and from this *idea* duly considered, will easily be deduced all those other *attributes* we ought to ascribe to this *eternal being*.

225. From what has been said, it is plain, we have a more certain knowledge of the existence of a *God*; than of any thing our senses have not immediately discovered to us; nay, that we more certainly know that there is a *God*, than that there is any thing else without us.

226. It being then unavoidable for all rational creatures to conclude, that *something has existed from eternity*; let us next see what *kind of thing* that must be. There are but two sorts of beings in the world, that man knows or conceives. First, Such as are purely material, without sense or perception, as the clippings of our beards, and parings of our nails.

Secondly,

Existence  
of a God.

Secondly, Sensible perceiving beings; such as we find ourselves to be. These two sorts we shall hereafter call *cogitative* and *incogitative* beings; which to our present purpose are better than *material* and *immaterial*.

228. If then there must be something *eternal*, it is very obvious to reason, that it must necessarily be a *cogitative* being; because it is as impossible to conceive that ever bare *incogitative* matter should produce a *thinking* intelligent being, as that nothing should of itself produce matter. Let us suppose any parcel of matter *eternal*, we shall find it in itself unable to produce any thing. Let us suppose its parts firmly at rest together: If there were no other being in the world, must it not eternally remain so, a dead unactive lump? Is it possible to conceive it can add motion to itself, or produce any? *Matter* then by its own strength cannot produce in itself so much as *motion*. The motion it has must also be from eternity, or else added to matter by some other being more powerful than matter. But let us suppose motion eternal too; yet matter, *incogitative* matter and motion, could never produce *thought*. Knowledge will still be as far beyond the *power of motion* and *matter* to produce, as matter is beyond the power of nothing to produce. Divide *matter* into as minute parts as you will, vary the figure and motion of it as much as you please, it will operate no otherwise upon other bodies of proportionable bulk than it did before this division. The minutest particles of matter knock, impel, and resist one another, just as the greater do; and that is all they can do. So that if we will suppose *nothing eternal*, *matter can never begin to be*: If we suppose *bare matter* without motion *eternal*, *motion can never begin to be*: If we suppose only matter and motion *eternal*, *thought can never begin to be*: For it is impossible to conceive that matter, either with or without motion, could have originally, in and from itself, sense, perception, and knowledge; as is evident from hence, that then sense, perception, and knowledge, must be a property eternally inseparable from matter and every particle of it. Since, therefore, whatsoever is the first eternal being, must necessarily be *cogitative*; and whatsoever is first of all things, must necessarily contain in it, and actually have, at least all the perfections that can ever after exist; it necessarily follows, that the *first eternal being cannot be matter*.

229. If therefore it be evident that something necessarily must exist from eternity, it is also evident that that *something must necessarily be a cogitative being*: For it is as impossible that *incogitative matter* should produce a *cogitative being*, as that nothing, or the negation of all being, should produce a positive being or matter.

230. This discovery of the necessary existence of an Eternal Mind, does sufficiently lead us into the knowledge of God. For it will hence follow, that all other knowing beings that have a beginning must depend on him, and have no other ways of knowledge or extent of power than what he gives them; and therefore if he made those, he made also the less excellent pieces of this universe, all *inanimate bodies*, whereby his *omniscience*, *power*, and *providence*, will be established; and from thence all his other attributes necessarily follow.

SECT. XXXVI. *Of our Knowledge of the Existence of other Things.*

231. THE knowledge of our own being we have by *intuition*: The existence of a God, *reason* clearly makes known to us. The *knowledge of the existence* of any other thing, we can have only by *sensation*: For there being no necessary connection of *real existence* with any idea a man hath in his memory; nor of any other existence, but that of God, with the existence of any particular man; no particular man can know the existence of any other being, but only when, by actually operating upon him, it makes itself be perceived by him. The having the idea of any thing in our mind, no more proves the existence of that thing, than the picture of a man evidences his being in the world, or the visions of a dream make thereby a true history. It is therefore the actual receiving of ideas from without, that gives us notice of the existence of other things, and makes us know that something doth exist at that time without us, which causes that idea in us, though perhaps we neither know nor consider how it does it; for it takes not from the *certainty* of our senses, and the ideas we receive by them, that we know not the manner wherein they are produced. This notice we have by our senses of the existing of things without us, though it be not altogether so certain as *intuition* and *demonstration*, deserves the name of *knowledge*, if we persuade ourselves that our faculties act and inform us right concerning the existence of those objects that affect them. But besides the assurance we have from our senses themselves, that they do not err in the information they give us of the existence of things without us, we have other concurrent reasons: As, 1. It is plain those perceptions are produced in us by exterior causes affecting our senses, because those that want the *organs of any sense* never can have the *ideas* belonging to that sense produced in their minds. This is too evident to be doubted; and therefore we cannot but be assured, that they come in by the organs of that sense, and no other way.

Secondly, Because we find sometimes that we cannot avoid the having those *ideas* produced in our minds. When my eyes are shut, I can with pleasure recall to my mind the *ideas of light* or the *sun*, which former sensations had lodged in my memory: But if I turn my eyes towards the *sun*, I cannot avoid the *ideas* which the *light* or the *sun* then produces in me. Which shews a manifest difference between those *ideas* laid up in the memory, and such as force themselves upon us and we cannot avoid having. And therefore it must needs be some *exterior* cause, whose efficacy I cannot resist, that produces those *ideas* in my mind whether I will or no.

233. Besides, there is nobody who doth not perceive the difference in himself, between actually looking upon the *sun*, and contemplating the *idea* he has of it in his memory; and therefore he hath certain knowledge, that they are not both memory or fancy, but that actual seeing has a cause without.

234. Thirdly, add to this, that many *ideas* are produced in us with pain, which we afterwards remember without the least offence. Thus the pain of *heat* or *vold*, when the *idea* of it is received in our minds, gives

istence. us no disturbance, which, when felt, was very troublesome; and we remember the pain of *hunger, thirst, head-ach,* &c. without any pain at all, which would either never disturb us, or else constantly do it as often as we thought of it, were there nothing more but *ideas* floating in our minds, and appearances entertaining our fancies, without the real existence of things affecting us from abroad.

235. *Fourthly,* Our *senses* in many cases bear witness to the truth of each other's report concerning the existence of sensible things without us: he that doubts when he sees a *fire,* whether it be *real,* may, if he please, feel it too; and by the exquisite pain he will be convinced, that it is not a bare *idea* or *phantom.*

236. If, after all this, any one will be so *sceptical* as to distrust his *senses,* and to question the existence of all things, or our knowledge of any thing, let him consider that the certainty of things existing in *rerum natura,* when we have the testimony of our *senses* for it, is not only as great as our frame can attain to, but as our condition needs. For our *faculties* being not suited to the full extent of beings, nor a clear comprehensive knowledge of all things, but to the preservation of us in whom they are, and accommodated to the use of life; they serve our purpose well enough, if they will but give us certain notice of those things that are convenient or inconvenient to us. For he that sees a *candle burning,* and has experimented the force of the flame by putting his finger in it, will little doubt that this is something existing without him which does him harm and puts him to pain: which is assurance enough; when no man requires greater certainty to govern his actions by, than what is as certain as his actions themselves. So that this evidence is as great as we can desire, being as certain to us as our pleasure or pain, that is, *happiness* or *misery;* beyond which we have no concernment either of knowing or being.

237. In fine, when our *senses* do actually convey into our understandings any *idea,* we are assured that there is something at that time *really existing* without us. But this knowledge extends only as far as the present testimony of our *senses,* employed about particular objects that do then affect them, and no farther. My seeing a *man* a minute since, is no certain argument of his present existence.

238. As when our *senses* are actually employed about any object, we know that it does exist; so by our memory we may be assured, that heretofore things that affected our *senses* have existed: And thus we have the knowledge of the past existence of several things, whereof our *senses* having informed us, our memories still retain the *ideas;* and of this we are past all doubt, so long as we remember well.

239. As to the *existence* of *spirits,* our having *ideas* of them does not make us know that any such things do exist without us, or that there are any *finite spirits,* or any other *spiritual beings* but the *eternal God.* We have ground from *revelation,* and several other reasons, to believe with assurance, that there are such creatures: But our *senses* not being able to discover them, we want the means of knowing their particular existence; for we can no more know that there are *finite spirits*

really existing, by the *ideas* we have of such beings, than by the *ideas* any one has of *fabries, or centaurs,* he can come to know, that things answering those *ideas* do really exist.

240. Hence we may gather, that there are *two sorts* of propositions: One concerning the existence of any thing answerable to such an *idea,* as that of an *elephant, phoenix, motion, or angel, viz.* whether such a thing does any where exist: And this knowledge is only of *particulars,* and not to be had of any thing without us, but only of *God,* any other way than by our *senses.*

241. Another sort of proposition is, wherein is expressed the agreement or disagreement of our *abstract ideas,* and their dependence one on another. And these may be *universal* and certain: so having the *idea* of *God* and my *self,* of *freedom* and *obedience,* I cannot but be sure that *God* is to be *feared* and *obeyed* by me: and this proposition will be certain concerning *man* in general, if I have made an *abstract idea* of such a *species,* whereof I am one particular. But such a proposition, how certain soever, proves not to me the existence of men in the world; but will be true of all such creatures, whenever they do exist: which *certainty* of such general propositions depends on the agreement or disagreement discoverable in those *abstract ideas.* In the former case, our knowledge is the consequence of the *existence* of things producing *ideas* in our minds by our *senses:* in the latter, the consequences of the *ideas* that are in our minds, and producing these general propositions, many whereof are called *eternal verities:* and all of them indeed are so; not from being written all or any of them in the minds of all men, or that they were any of them propositions in any one's mind, till he, having got the *abstract ideas,* joined or separated them by affirmation or negation; but whereforever we can suppose such a creature as *man* is, endowed with such faculties, and thereby furnished with such *ideas* as we have, we must conclude he must needs, when he applies his thoughts to the consideration of his *ideas,* know the truth of certain propositions that will arise from the agreement or disagreement he will perceive in his own *ideas.* Such propositions being once made about *abstract ideas,* so as to be true, they will, whenever they can be supposed to be made again, at any time past, or to come, by a mind having those *ideas,* always be true: for names being supposed to stand perpetually for the same *ideas,* and the same *ideas* having immutably the same habitudes one to another, propositions concerning any *abstract ideas* that are once true must needs be *eternal verities.*

#### SECT. XXXVII. Of Judgment.

242. THE *understanding faculties* being given to man, not barely for speculation, but also for the conduct of his life, a man would be at a great loss, if he had nothing to direct him but what has the certainty of true knowledge. He that will not eat till he has demonstration that it will nourish him, nor stir till he is infallibly assured of success in his business, will have little else to do but sit still, and *perish.*

243. Therefore as *God* hath let some things in broad day-light; as he has given us some certain knowledge, though limited to a few things in comparison,

*Probability.* (probably as a taste of what *intellectual* creatures are capable of, to excite in us a desire and endeavour after a better state;) so, in the greatest part of our concernment, he has afforded us only the *twilight* of *probability*, suitable to that state of *mediocrity* and *probationship* he has pleased to place us in here.

244. The faculty which God has given man to enlighten him, next to certain knowledge, is *judgment*; whereby the mind takes its *ideas* to agree or disagree, without perceiving a demonstrative evidence in the proofs. The mind exercises this judgment sometimes out of *necessity*, where demonstrative proofs and certain knowledge are not to be had; and sometimes out of *laziness*, unskilfulness, or haste, even where they are to be had.

245. This faculty of the mind, when it is exercised immediately about things, is called *judgment*: when about truths delivered in words, is most commonly called *assent* or *dissent*. Thus the mind has two *faculties* conversant about truth and falsehood: First, *Knowledge*; whereby it certainly perceives, and is undoubtedly satisfied of the agreement or disagreement of any ideas. Secondly, *Judgment*; which is the putting *ideas* together, or separating them from one another in the mind, when their certain agreement or disagreement is not perceived, but presumed to be so. And if it *joins* or separates them as in reality things are, it is *right judgment*.

#### SECT. XXXVIII. Of Probability.

246. PROBABILITY is nothing but the appearance of the agreement or disagreement of two *ideas*, by the intervention of proofs, whose connection is not constant and immutable, or is not perceived to be so; but is or appears for the most part to be so; and is enough to induce the mind to judge the proposition to be *true* or *false*, rather than the contrary.

247. Of *probability* there are degrees, from the neighbourhood of *certainty* and *demonstration*, quite down to *improbability* and *unlikeliness*, even to the confines of *impossibility*: And also degrees of *assent*, from *certain knowledge*, and what is next it, *full assurance* and *confidence*, quite down to *conjecture*, *doubt*, *distrust*, and *disbelief*.

248. That proposition then is *probable*, for which there are arguments or proofs to make it pass or be received for *true*: The entertainment the mind gives to this sort of propositions, is called *belief*, *assent*, or *opinion*. *Probability* then being to supply the defect of our knowledge, is always conversant about propositions whereof we have no *certainty*, but only some *inducements* to receive them for true. The *grounds* of it are, in short, *these two* following.

*First*, The conformity of any thing with our own knowledge, experience, or observation.

*Secondly*, The testimony of others, vouching their observation and experience. In the *testimony* of others is to be considered, *First*, The number; *Secondly*, The integrity; *Thirdly*, The skill of the witnesses; *Fourthly*, The design of the author, if it be a testimony cited out of a book; *Fifthly*, The consistency of the parts and circumstances of the relation; *Sixthly*, Contrary testimonies.

249. The mind, before it rationally *assents* or *dissents* to any probable proposition, ought to examine all the *grounds* of *probability*, and see how they make,

more or less, for or against it; and upon a due balancing of the whole, reject or receive it, with a more or less firm *assent*, according to the preponderancy of the greater *grounds* of *probability* on one side or the other.

#### SECT. XXXIX. Of the Degrees of Assent.

250. The *grounds* of *probability*, laid down in the foregoing section, as they are the foundations on which our *assent* is built, so are they also the measure whereby its several *degrees* are (or ought to be) regulated. Only we are to take notice, that no *grounds* of *probability* operate any farther on the mind, which searches after truth, and endeavours to judge right, than they appear, at least, in the first judgment or search that the mind makes. It is indeed in many cases impossible, and in most very hard, even for those who have admirable memories, to retain all the proofs which, upon a due examination, made them embrace that side of the question. If suffices that they have once, with care and fairness, sifted the matter as far as they could; and having once found on which side the *probability* appeared to them, they lay up the conclusion in their memories, as a *truth* they have discovered; and for the future remain satisfied with the testimony of their memories, that this is the opinion, that, by the proofs they have once seen of it, deserves such a *degree* of their *assent* as they afford it.

251. It is unavoidable then that the memory be relied on in this case, and that men be persuaded of several *opinions*, whereof the proofs are not actually in their thoughts, nay, which perhaps they are not able actually to recall: without this the greatest part of men must be either *sceptics*, or change every moment, when any one offers them arguments which, for want of memory, they are not presently able to answer.

252. It must be owned, that mens sticking to past judgments, is often the cause of great *obstinacy* in error and mistake. But the fault is not that they rely on their memories for what they have before well judged, but because they judged before they had well examined. Who almost is there that hath the leisure, patience, and means, to collect together all the proofs concerning most of the opinions he has, so as safely to conclude, that he has a clear and full view, and that there is no more to be alleged for his better information? And yet we are forced to determine ourselves on one side or other: the conduct of our lives, and the management of our great concerns, will not bear delay: For those depend, for the most part, on the determination of our judgment in points wherein we are not capable of certain knowledge, and in where it is necessary for us to embrace one side or the other.

253. The propositions we receive upon inducements of *probability* are of two sorts: *First*, Concerning some particular existence, or matter of *fact*, which falling under our observation, is capable of *human testimony*: *Secondly*, Concerning things which, being beyond the discovery of our *senses*, are not capable of human testimony.

Concerning the first of these, *viz. Particular matter of fact*.

254. *First*, Where any particular thing consonant to the constant observation of ourselves, and others, in the like case, comes attested with the concurrent reports

ports of all that mention it, we receive it as easily, and build as firmly upon it, as if it were certain knowledge. Thus, if all *Englishmen*, who have occasion to mention it, should report, that it *froze* in England last winter, or the like, a man would as little doubt of it, as that *even* and *four* are eleven.

preponderate on either side, so they are fitted to produce in the mind such different entertainments, as are called *belief, conjecture, guess, doubt, wavering, distrust, disbelief, &c.*

Degrees of Assent.

259. It is a rule generally approved, that any testimony, the farther off it is removed from the original truth, the less force it has: and in *traditional* truths, each remove weakens the force of the *proof*. There is a rule quite contrary to this, advanced by some men, who look on *opinions* to gain force by growing *older*. Upon this ground, propositions evidently false or doubtful in their first beginning, come by an inverted rule of *probability* to pass for *authentic* truths; and those which deserved little credit from the mouths of their first relators, are thought to grow *venerable* by age, and are urged as undeniable.

260. But certain it is, that no *probability* can rise above its first original. What has no other evidence than the single testimony of one witness, must stand or fall by his only testimony, though afterwards cited by hundreds of others; and is so far from receiving any strength thereby, that it becomes the weaker; because passion, interest, inadvertency, mistake of his meaning, and a thousand odd reasons, which capricious mens minds are acted by, may make one man quote another's words or meaning wrong. This is certain, that what in one age was affirmed upon slight grounds, can never after come to be more valid in future ages by being often repeated.

261. The second sort of *probability*, is concerning things not falling under the reach of our senses, and therefore not capable of testimony: and such are,

262. (1.) The existence, nature, and operations of *finite immaterial* beings without us, as *spirits, angels, &c.* or the existence of *material* beings, such as, for their smallness or remoteness, our senses cannot take notice of; as whether there be any *plants, animals, &c.* in the *planets*, and other mansions of the vast universe.

263. (2.) Concerning the manner of operation in most parts of the works of *nature*; wherein though we see the sensible effects, yet their causes are unknown, and we perceive not the ways and manner how they are produced. We see *animals* are generated, nourished, and move; the *loadstone* draws *iron, &c.* But the causes that operate, and the manner they are produced, we can only guess, and probably conjecture. In these matters *analogy* is the only help we have; and it is from that alone we draw all our grounds of *probability*. Thus observing, that the bare rubbing of two bodies violently upon one another, produces *heat*, and very often *fire*, we have reason to think, that what we call *heat* and *fire* consists in a certain violent agitation of the imperceptible minute parts of the burning matter.

This sort of *probability*, which is the best conduct of rational experiments, and the rise of *hypotheses*, has also its use and influence. And a wary reasoning from *analogy* leads us often into the discovery of *truths* and useful *deductions*, which would otherwise lie concealed.

264. Though the common experience, and the ordinary course of things, have a mighty influence on the minds of men, to make them give or refuse credit to any thing proposed to their belief; yet there is one case wherein the strangeness of the fact lessens not the assent to a fair testimony given of it. For where such *supernatural events* are suitable to ends aimed at by

255. The first and highest degree of *probability* then is, when the general consent of all men, in all ages, as far as can be known, concurs with a man's own constant experience in the like cases, to confirm the truth of any particular matter of fact, attested by fair witnesses. Such are the stated *constitutions* and *properties* of bodies, and the regular proceedings of *causes* and *effects* in the ordinary course of *nature*. This we call an *argument* from the nature of things themselves: For what we and others always observe to be after the same manner, we conclude with reason to be the effects of steady and regular *causes*, though they come not within the reach of our knowledge; as that fire warmed a man, or made lead *fluid*; that iron sunk in water, or swam in quicksilver. A relation affirming any such thing to have been, or a predication that it will happen again in the same manner, is received without doubt or hesitation; and our *belief* thus grounded, rises to *assent*.

256. Secondly, The next degree of *probability*, is when by my own experience, and the agreement of all others that mention it, a thing is found to be for the most part so; and that the particular instance of it is attested by many and undoubted witnesses. Thus *history* giving us such an account of men in all ages, and my own experience confirming it, that most men prefer their own private advantage to the public; if all historians that write of *Tiberius*, say that he did so, it is extremely probable: And in this case, our assent rises to a degree which we may call *confidence*.

257. Thirdly, In matters happening indifferently, as that a *bird* should fly this or that way; when any particular matter of fact comes attested by the concurrent testimony of unsuspected witnesses, there our assent is also unavoidable. Thus, that there is in *Italy* such a city as *Rome*; that about one thousand and eight hundred years ago there lived such a man in it as *Julius Caesar, &c.* a man can as little doubt of this, and the like, as he does of the being and actions of his own acquaintance, whereof he himself is a witness.

258. *Probability*, on these grounds, carries so much evidence with it, that it leaves us as little liberty to believe or disbelieve, as demonstration does, whether we will know or be ignorant. But the difficulty is, when testimonies contradict common experience, and the reports of witnesses clash with the ordinary course of nature, or with one another; here diligence, attention, and exactness, is required to form a *right judgment*, and to proportion the assent to the evidence and *probability* of the thing, which rises and falls according as the two foundations of credibility favour or contradict it. These are liable to such variety of contrary observations, circumstances, reports, tempers, designs, oversight, &c. of reporters, that it is impossible to reduce to precise rules the various degrees wherein men give their assent. This in general may be said, that as the *proofs*, upon due examination, shall to any one appear in a greater or less degree to

Reason.

Him who has the power to change the course of nature, there, under such circumstances, they may be the fitter to procure belief, by how much the more they are beyond or contrary to ordinary observation. This is the proper case of *miracles*; which, well attested, do not only find credit themselves, but give it also to other *truths*.

265. There are propositions that challenge the highest degree of our *assent* upon bare testimony, whether the thing proposed agree or disagree with common experience and the ordinary course of things or no: the reason whereof is, because the testimony is of such an *one* as cannot deceive nor be deceived; and that is *God* himself. This carries with it certainty beyond doubt, evidence beyond exception. This is called by a peculiar name, *revelation*, and our *assent* to it, *faith*, which has as much certainty in it as our knowledge itself; and we may as well doubt of our own being, as we can whether any *revelation* from *God* be true. So that *faith* is a settled and sure principle of *assent* and *assurance*, and leaves no manner of room for doubt or hesitation; only we must be sure, that it be a divine *revelation*, and that we understand it right, else we shall expose ourselves to all the extravagancy of *enthusiasm*, and all the error of wrong principles, if we have *faith* and *assurance* in what is not *divine revelation*.

## SECT. XL. Of Reason.

266. THE word *reason*, in *English*, has different significations. Sometimes it is taken for *true* and *clear principles*; sometimes for *clear* and *fair deductions* from those principles; sometimes for the *cause*, and particularly for the *final cause*: but the consideration we shall have of it here, is as it stands for a *faculty* whereby *man* is supposed to be distinguished from *beasts*, and wherein it is evident he much surpasses them.

267. Reason is necessary, both for the enlargement of our knowledge and regulating our assent; for it hath to do both in knowledge and opinion, and is necessary and assisting to all our other intellectual faculties; and indeed contains two of them, *viz.* first, *Sagacity*, whereby it finds intermediate *ideas*; secondly, *Illation*, whereby it so orders and disposes of them, as to discover what connection there is in each link of the chain, whereby the extremes are held together, and thereby, as it were, to draw into view the truth sought for; which is that we call *illation*, or *inference*, and consists in nothing but the perception of the connection there is between the *ideas* in each step of the deduction; whereby the mind comes to see either the certain agreement or disagreement of any two *ideas*, as in *demonstration*, in which it arrives at knowledge; or their probable connection, on which it gives or withhold its *assent*, as in *opinion*.

268. *Sense* and *intuition* reach but a little way: the greatest part of our knowledge depends upon deductions and intermediate *ideas*. In those cases where we must take propositions for true, without being certain of their being so, we have need to find out, examine, and compare the grounds of their probability: in both cases, the faculty which finds out the means, and rightly applies them to discover certainty in the one, and probability in the other, is that which we call *reason*: so that in reason we may consider these four degrees; *First*, The discovering and finding out of proofs. *Se-*

Reason.

*condly*, The regular and methodical disposition of them, and laying them in such order as their connection may be plainly perceived. *Thirdly*, The perceiving their connection. *Fourthly*, The making a rhetorical conclusion.

269. There is one thing more which deserves to be considered concerning *reason*; and that is, whether *sylogism*, as is generally thought, be the proper instrument of it, and the usefullest way of exercising this faculty. The causes to doubt of it, are these:

270. *First*, Because *sylogism* serves our *reason* but in one only of the forementioned parts of it; and that is, to shew the connection of the proofs of any one instance, and no more: but in this it is of no great use, since the mind can perceive such connection, where it really is, as easily, nay perhaps better, without it. We may observe, that there are many men that reason exceeding clear and rightly, who know not how to make a *sylogism*; and scarce any one make *sylogisms* in reasoning within himself. Indeed, sometimes they may serve to discover a fallacy, hid in a rhetorical flourish; or, by stripping an absurdity of the cover of wit and good language, shew it in its naked deformity: but the weakness or fallacy of such a loose discourse it shews, by the artificial form it is put into, only to those who have thoroughly studied *mode* and *figure*, and have so examined the many ways that three propositions may be put together, as to know which of them does certainly conclude right, and which not, and upon what grounds it is that they do so: but they who have not so far looked into those forms, are not sure, by virtue of *sylogism*, that the conclusion certainly follows from the premises; the mind is not taught to reason by these *rules*; it has a native faculty to perceive the coherence or incoherence of its *ideas*, and can range them right without any such perplexing *repetitions*.

271. And to shew the weakness of an argument, there needs no more but to strip it of the superfluous *ideas*, which, blended and confounded with those on which the inference depends, seem to shew a connection where there is none, or at least to hinder the discovery of the want of it; and then to lay the naked *ideas*, on which the force of the argumentation depends, in their due order; in which position the mind, taking a view of them, sees what connection they have, and so is able to judge of the inference without any need of *sylogism* at all.

272. *Secondly*, Because *sylogisms* are not less liable to fallacies than the plainer ways of argumentation. And for this we appeal to common observation, which has always found these artificial methods of reasoning more adapted to catch and entangle the mind, than to instruct and inform the understanding. And if it be certain that fallacy can be couched in *sylogisms*, as it cannot be denied, it must be something else, and not *sylogism*, that must discover them: but if men skilled in and used to *sylogisms*, find them assisting to their reason in the discovery of truth, we think they ought to make use of them. All that we aim at is, that they should not ascribe more to these forms than belongs to them; and think that men have no use, or not so full a use, of their reasoning faculty without them.

273. But however it be in knowledge, it is of far less, or no use at all in *probabilities*: for the *assent* there being to be determined by the preponderancy, after a due weighing of all the proofs on both sides, nothing

Reason.

Reason.

is so unfit to assist the mind in that as *fillogisim*; which running away with one assumed *probability*, pursues that till it has led the mind quite out of sight of the thing under consideration.

274. But let it help us (as perhaps may be said) in convincing men of their errors or mistakes: yet still it fails our reason in that part, which if not its highest perfection, is yet certainly its hardest task, and that which we most need its help in; and that is, the *finding out of proofs and making new discoveries*. This way of reasoning discovers no new proofs, but is the art of marshalling and ranging the old ones we have already. A man knows first, and then he is able to prove *fillogistically*; so that *fillogisim* comes after knowledge; and then a man has little or no need of it. But it is chiefly by the finding out those *ideas* that shew the connection of distant ones, that our stock of knowledge is increased, and that useful arts and sciences are advanced.

275. Reason, though of a very large extent, fails us in several instances; as, *first*, Where our ideas fail. *Secondly*, It is often at a loss, because of the obscurity, confusion, or imperfection of the *ideas* it is employed about. Thus having no perfect *idea* of the least extension of *matter*, or of *infinity*, we are at a loss about the divisibility of *matter*. *Thirdly*, Our *reason* is often at a stand, because it perceives not those *ideas* which would serve to shew the certain or probable agreement or disagreement of any two other *ideas*. *Fourthly*, Our *reason* is often engaged in absurdities and difficulties, by proceeding upon false principles, which being followed lead men into contradictions to themselves, and inconsistency in their own thoughts. *Fifthly*, Dubious words, and uncertain signs, often puzzle mens *reasons*, and bring them to a nonplus.

276. Though the deducing one proposition from another be a great part of reason, and that which it is usually employed about; yet the principal act of ratiocination, is the finding the agreement or disagreement of two *ideas* one with another, by the intervention of a third; as a man, by a yard, finds two houses to be of the same length, which could not be brought together to measure their equality by *juxta-position*: words have their consequences as the signs of such *ideas*: and things agree or disagree, as really they are; and we observe it only by our *ideas*.

In reasoning, men ordinarily use four sorts of *arguments*.

277. The *first* is to allege the opinions of men, whose parts, learning, eminence, power, or some other cause, has gained a name, and settled their reputation in the common esteem with some kind of authority: this may be called *argumentum ad verecundiam*.

278. *Secondly*, Another way is, to require the adversary to admit what they allege as a proof, or to af-

sign a better: this is called *argumentum ad ignorantiam*.

279. A *third* way, is to press a man with consequences drawn from his own principles or convictions: this is known under the name of *argumentum ad hominem*.

280. *Fourthly*, The using of proofs drawn from any of the foundations of knowledge or probability: this is called *argumentum ad judicium*. This alone, of all the four, brings true instruction with it, and advances us in our way to knowledge: for, first, It argues not another man's opinion to be right, because I, out of respect, or any other consideration but that of conviction, will not contradict him. Secondly, It proves not another man to be in the right way, nor that I ought to take the same with him, because I know not a better. Thirdly, Nor does it follow, that another man is in the right way, because he has shewn me that I am in the wrong: this may dispose me, perhaps, for the reception of truth, but helps me not to it; that must come from *proofs and arguments*, and light arising from the nature of things themselves; not from my shamefacedness, ignorance, or error.

281. By what has been said of *reason*, we may be able to make some guess at the distinction of things into those that are according to, above, and contrary to, *reason*. According to *reason*, are such propositions whose truth we can discover by examining and tracing those *ideas* we have from *sensation and reflection*, and by natural deduction find to be true or probable. Above *reason*, are such propositions, whose truth or probability we cannot by *reason* derive from those principles. Contrary to *reason*, are such propositions as are inconsistent with, or irreconcilable to, our clear and distinct *ideas*. Thus the existence of one God, is according to *reason*; the existence of more than one God, contrary to *reason*; the resurrection of the body after death, above *reason*. Above *reason*, may be also taken in a double sense, viz. above probability, or, above certainty: in that large sense also, contrary to *reason* is sometimes taken.

282. There is another use of the word *reason*, wherein it is opposed to *faith*; which, though authorized by common use, yet is in itself a very improper way of speaking: for *faith* is nothing but a firm assent of the mind; which, if it be regulated as is our duty, cannot be afforded to any thing but upon good *reason*, and so cannot be opposite to it: he that believes without having any reason for believing, may be in love with his own fancies; but neither seeks truth as he ought, nor pays the obedience due to his Maker, who would have him use those discerning faculties he has given him, to keep him out of mistake and error.

M E T

METAPLASMUS, in grammar, a transmutation or change made in a word, by adding, retrenching, or altering a syllable or letter thereof.

METAPONTIUM, or METAPONTIUM, (anc. geog.), a town of Lucania, on the Sinus Tarentinus, to the west of Tarentum; built by the Pylians, who returned from Troy, (Mela). Where Pythagoras is said to have taught in the time of Servius Tullius,

M E T

(Livy). *Metapontini*, the people; who pretended to shew, in a temple of Minerva, the tools with which Epæus built the wooden horse, (Justin). Now a tower, called *Torre di Mare*, in the Basilicata of Naples, (Baudrand).

METASTASIS, in medicine, a transposition, or settlement of some humour or disease on some other part; and sometimes it signifies such an alteration of a disease

Metatarfus disease as is succeeded by a solution.

METATARSUS, in anatomy. See there, n<sup>o</sup> 69.  
 METATHESIS, in grammar, a species of the metaplasmus; being a figure whereby the letters or syllables of a word are transposed, or shifted out of their usual situations, as *pisistris* for *pristis*, *Lybia* for *Libya*, &c.

This word is, by physicians, used with respect to morbid causes; which, when they cannot be evacuated, are removed to places where they are less injurious.

METEMPSYCHOSIS, the doctrine of transmigration, which supposes, that human souls, upon their leaving the body, become the souls of such kind of brutes as they most resemble in their manners.

This was the doctrine of Pythagoras and his followers, who held, that the souls of vicious men were imprisoned in the bodies of miserable beasts, there to do penance for several ages, at the expiration whereof they returned again to animate men; but if they had lived virtuously, some happier brute, or even a human creature, was to be their lot. What led Pythagoras into this opinion was the persuasion he had that the soul was not of a perishable nature; whence he concluded, that it must move into some other body upon its abandoning this. Lucan thinks this doctrine was contrived to mitigate the apprehension of death, by persuading men that they only changed their lodgings, and ceased to live only to begin a new life. Reuchlin denies this doctrine, and maintains, that the metempsychosis of Pythagoras implied nothing more than a similitude of manners and desires formerly existing in some person deceased, and now reviving in another alive. Pythagoras is said to have borrowed the notion of a metempsychosis from the Egyptians; others say from the ancient Brachmans. It is still retained among the ancient Banians, and other idolaters of India and China, and makes the principal foundation of their religion. Many of the modern Jews are said to espouse this doctrine; and, to support their opinion, quote these words of Job, "Lo all these things worketh God oftentimes with man (in Hebrew, *and thrice*) to bring back his soul from the pit to be enlightened with the light of the living." It is certain, that at the time of Jesus Christ this opinion was very common among the Jews: this appears in the gospel, when they say, that some thought Jesus Christ to be John the Baptist, others Elias, others Jeremiah, &c.

METEMPTOSIS, a term in chronology, expressing the solar equation, necessary to prevent the new moon from happening a day too late; by which it is opposed to proemptions, which signifies the lunar equation necessary to prevent the new moon from happening a day too soon. The new moon's running a little backward, that is, coming a day too soon, at the end of three hundred twelve years and a half; by the proemptions a day is added every three hundred years, and another every two thousand four hundred years. On the other hand, by the metemptions, a bissextile is suppressed every one hundred and thirty-four years; that is, three times in four hundred years. These alterations are never made but at the end of each century; that period being very remarkable, and rendering the practice of the kalendar easy.

There are three rules for making this addition or

suppression of the bissextile day, and by consequence for changing the index of the epacts. 1. When there is a metemptions, the next following, or lower index, must be taken. 2. When there is a proemptions without a metemptions, the next preceding or superior index is to be taken. 3. When there are both a metemptions and proemptions, or when there is neither the one nor the other, the same index is preserved.

METEOR, (by the Greeks called *μειταρα*, q. d. *sublima*, or "high raised;") by the Latins *impressiones*, as making signs or impressions in the air), commonly denotes any bodies in the air that are of a flux or transitory nature. Hence it is extended to the phenomena of hail, rain, snow, thunder, &c.; but is most commonly confined to those unusual and fiery appearances named *falling-stars*, *ignes fatui*, *auroræ boreales*, &c. whether they appear at a great distance from the earth or not.—Till the discovery of electricity these meteors could not be accounted for: but they are now resolved, by the almost universal consent of philosophers, into the action of that fluid; which, tho' unheeded, hath shewed itself in all ages.

A luminous appearance, which must have been of an electric nature, is mentioned by Plutarch in his life of Lyfander; who considers it as a meteor. Pliny, in his second book of Natural History, calls those appearances *stars*; and tells us, that they settled not only upon the masts, and other parts of ships, but also upon mens heads. "Stars, says he, make their appearance, both on land and sea. I have seen a light in that form on the spears of soldiers keeping watch by night upon the ramparts. They are seen also on the sail-yards, and other parts of the ships, making an audible sound, and frequently changing their places. Two of these lights forebode good weather and a prosperous voyage; and drive away the single one, which wears a threatening aspect. This the sailors call *Helen*; but the two they call *Castor* and *Pollux*, and invoke them as gods. These lights do sometimes, about the evening, rest on mens heads, and are a great and good omen." Seneca, in his natural questions, chap. 1. takes notice of the same phenomenon. "A star (says he) settled on the lance of Gylippus, as he was sailing to Syracuse: and spears seemed to be on fire in the Roman camp." In Cæsar we find the same appearances attending a violent storm. "About that time, (says the author,) there was a very extraordinary appearance in the army of Cæsar. In the month of February, about the second watch of the night, there suddenly arose a thick cloud, followed by a shower of stones; and the same night, the points of the spears belonging to the fifth legion seemed to be on fire." Livy also mentions two similar facts. "The spears of some soldiers in Sicily, and a walking stick which a horseman in Sardinia was holding in his hand, seemed to be on fire. The shores were also luminous with frequent fires."

These appearances are called, both by the French and Spaniards inhabiting the coasts of the Mediterranean, *St Helme's* or *St Telme's fires*; by the Italians, the *fires of St Peter* and *St Nicholas*; and are frequently taken notice of by the writers of voyages. If some late accounts from France are to be depended upon, this phenomenon has been observed at Plauzet for time immemorial; and Mr Binon, the curate of the place,

Meteor.

says,



says, that for 27 years, during which he resided there, in great storms accompanied with black clouds, and frequent lightning, the three-pointed extremities of the cross of the temple of that place appeared surrounded with a body of flame; and that when this phenomenon has been seen, the storm was no longer to be dreaded, and calm weather returned soon after.

Modern history furnishes a great many examples of a similar kind; but the most remarkable of these terrestrial meteors, if they may be so called, is the *ignis fatuus*, or, in common English, *Will with a wisp*, to which the credulous vulgar ascribe very extraordinary and especially mischievous powers. This phenomenon is chiefly visible in damp places, and is also said to be very often seen in burying grounds, and near dung-hills. Travellers say, that it is very frequent near Bologna in Italy, and in several parts of Spain and Ethiopia. The form and size of it are very various, and often variable.

It was the opinion of many philosophers, and especially Willoughby and Ray, that the *ignis fatuus* is made by shining insects; but this opinion was never well supported. Sir Isaac Newton calls it a *vapour shining without heat*, and supposes that there is the same difference between this vapour and flame, that there is between wood shining without heat, and burning coals of fire. That this opinion is just, and, moreover, that the light of this vapour shining without heat is of the same nature with light from putrescent substances, may, according to Dr Priestley, be concluded from the following circumstances relating to them, as described by Dr Derham, and G. B. Beccari.

The former of these gentlemen, having observed an *ignis fatuus* in some boggy ground, between two rocky hills, in a dark and calm night, got by degrees within two or three yards of it, and thereby had an opportunity of viewing it to the greatest advantage. It kept skipping about a dead thistle, till a slight motion of the air, occasioned, as he supposed, by his near approach to it, made it jump to another place; and as he advanced, it kept flying before him. He was so near to it, that, had it been the shining of glow-worms, he was satisfied that he could not but have distinguished the separate lights of which it must have consisted; whereas it was one uniform body of light. He therefore thought that it must be an ignited vapour. Similar in some respects to this light, was one that surrounded the body and the bed of a woman at Milan, which fled from the hand that approached it, but was at length dispersed by the agitation of the air.

Mr Beccari made it his business to inquire concerning this phenomenon of all his acquaintance, who had had opportunities of observing it, either on the mountains, or on the plain. He found that two which appeared on the plains, one to the north, and the other to the east of Bologna, were to be seen almost every dark night, especially the latter; and the light they gave was equal to that of an ordinary faggot. That to the east of Bologna once appeared to a gentleman of his acquaintance, as he was travelling, and kept him company above a mile, constantly moving before him, and casting a stronger light upon the road than the torch which was carried along with him. All these

luminous appearances, he says, gave light enough to make all the neighbouring objects visible, and they were always observed to be in motion, but this motion was various and uncertain. Sometimes they would rise up, and at other times sink; but they commonly kept hovering about six feet from the ground. They would also disappear of a sudden, and instantly appear again in some other place. They differed both in size and figure, sometimes spreading pretty wide, and then again contracting themselves; sometimes breaking into two, and then joining again; sometimes floating like waves, and dropping, as it were, sparks of fire. He was assured that there was not a dark night all the year round in which they did not appear, and that they were observed more frequently when the ground was covered with snow, than in the hottest summer; nor did rain or snow in the least hinder their appearance; but, on the contrary, they were observed more frequently, and cast a stronger light in rainy and wet weather; nor were they much affected by the wind.

The grounds to the east of Bologna, where the largest of these appearances was seen, is, he says, a hard chalky and clayey soil, which will retain the water a long time, and afterwards, in hot weather, would break into large cracks; but on the mountains, where the *ignis fatuus* were smaller, the soil was of a loose sandy texture, which would not keep the water very long. According to the best information he could procure, these lights very much frequent brooks and rivers, being often observed on the banks of them; perhaps, he says, because the current of air carries them thither more readily than to any other place.

This gentleman concludes his account of these appearances with the following curious narrative. An intelligent gentleman travelling in March, between eight and nine in the evening, in a mountainous road, about ten miles south of Bologna, perceived a light, which shone very strongly upon some stones which lay on the banks of the river Riverde. It seemed to be about two feet above the stones, and not far from the water. In size and figure it had the appearance of a parallelopiped, somewhat more than a foot in length, and half a foot high, the longest side being parallel to the horizon. Its light was so strong, that he could plainly distinguish by it part of a neighbouring hedge, and the water of the river; only in the east corner of it the light was rather faint, and the square figure less perfect, as if it was cut off or darkened by the segment of a circle.

His curiosity tempting him to examine this appearance a little nearer, he advanced gently towards the place; but was surpris'd to find that it changed gradually from a bright red, first to a yellowish, and then to a pale colour, in proportion as he drew nearer; and when he came to the place itself it quite vanished. Upon this he stepped back, and not only saw it again, but found that the farther he went from it, the stronger and brighter it grew. When he examined the place of this luminous appearance, he could not perceive the least smell, or any other mark of fire.

This extraordinary account was confirmed to Mr. Beccari by another gentleman, who frequently travelled the same road, and who assured him that he had seen the very same light five or six different times, in spring and autumn, and that he had always observed

Meteor. it to be of the very same shape, and in the same place; and he once took particular notice of its coming out of a neighbouring place, and settling itself in the figure above described.

M. Beccari owns himself to be greatly at a loss to account not only for this very remarkable appearance, but also for the *ignes fatui* in general. He only says, that all persons who ever saw any of these appearances, agree, that they cast a light quite different from that of shining fires.

Dr Shaw describes an *ignis fatuus*, which he saw in the Holy Land, the circumstances of which are very remarkable. As he and his company were travelling by night, through the valleys of mount Ephraim, they were attended, more than an hour, by an *ignis fatuus*, which was sometimes globular, or in the form of the flame of a candle; and which would, immediately afterwards, spread itself so much as to involve the whole company in a pale inoffensive light, and then contract itself again, and suddenly disappear. But in less than a minute it would become visible as before; or, running along from one place to another, with a swift progressive motion, would expand itself, at certain intervals, over more than two or three acres of the adjacent mountains. The atmosphere, from the beginning of the evening, had been remarkably thick and hazy, and the dew, as they felt it upon their bridges, was unusually clammy and unctuous. In the same kind of weather, he says, he has observed those luminous appearances, which, at sea, skip about the masts and yards of ships, and which the sailors call *corpufanse*, which is a corruption of the Spanish *corpofanto*.

Of the *celestial* meteors, the most common are those called *falling-stars*, which are so well known, that it is needless to describe them. They do very often appear of a larger size than the brightest fixed stars, tho' sometimes they equal Jupiter, or even Venus in apparent bulk, and are then exceedingly bright. They sometimes rise high in the air; for Mr Brydote takes notice of his having seen them as high to appearance above the top of Mount *Ætna*, as they usually appear when viewed from the ordinary ground. Sometimes, however, they are much lower. Signior Beccari mentions one which seemed to direct its course towards the place where he sat, growing continually larger and larger as it advanced, till at last it disappeared at no great distance, and left the faces, hands, and clothes, of those who saw it, and all the neighbouring objects, suddenly illuminated with a diffused and lambent light attended with no noise at all. While they were starting up, standing and looking at one another, surprised at the appearance, a servant came running to them out of a neighbouring garden, and asked them if they had seen nothing; for that he had seen a light shine suddenly in the garden, and especially upon the streams which he was throwing to water it.

The other kinds of celestial meteors are, *aurora borealis*, lightning of various forms, and large fire-balls. All these too sometimes appear very high, and sometimes very low; the fire-balls especially, will sometimes strike the ground, and explode with great violence, producing many mischievous effects. See *ATMOSPHERE*, *AURORA BOREALIS*, *CLOUD*, *LIGHTNING*, &c.

The general principles on which the phenomena of meteors depend, have already been so fully explained under the article *ELECTRICITY*, &c. that very little remains to be added in this place. The inoffensive lights, such as appear on the points of metallic bodies, the *ignis fatuus*, &c. are occasioned by a current of electric matter setting into or out of any particular body; for wherever that fluid is much agitated, there a light will be visible. If at the same time there is a considerable difference between the electricity of the atmosphere and the surface of the ground, the electric stream will be quietly imbibed, and no dangerous consequences will ensue to those who approach it; but if the electricity of the atmosphere and the ground happens to be much the same, the fluid will then be much compressed, will burn, explode, and produce all the mischief of the forked or crooked lightning, or of that kind which appears in the form of balls, and which is fully explained under the article *LIGHTNING*.

**METHOD**, the arrangement of our ideas in such a regular order, that their mutual connection and dependence may be readily comprehended. See *LOGIC*, n<sup>o</sup> 114.—118.

**METHODISTS**, a name at first given to a society of religious young men at Oxford, and now applied to all those who adhere to the doctrine of the church of England as taught by Whitefield, Wesley, &c. They are said to be, in general, plain well-meaning people, who do not dissent from the established church, but profess to live with great purity according to her articles. At their first appearance their teachers were charged, in the heat of their zeal, with several irregularities, and many expressions in their preaching which were not altogether unexceptionable: but as the civil government, with a moderation and wisdom peculiar to the present time, thought fit to overlook their behaviour, they have since honestly acknowledged where-in they were mistaken; and, in consequence of the perfect liberty of conscience they enjoy, have submitted to a more regular and peaceable conduct, agreeable to the genuine spirit of Christianity.

**METHODISTS**, *Methodici*, is also an appellation given to a set of ancient physicians, who reduced the whole healing art to a few common principles or appearances.

**METHODIUS**, a father of the church, bishop of Olympus or Patara in Lycia, and afterward of Tyre in Palestine, suffered martyrdom at Chalcis in Greece toward the end of Dioclesian's persecution in the year 302. He composed many works in a clear and elaborate style, which were extant in Jerome's time. Father Combefis collected several considerable fragments of this writer, cited by Epiphanius, Photius, and others; and printed them with notes of his own, together with the works of Amphilocheus, and Andreas Cretenis, in folio, Paris 1644.

**METIUS** (James), of Alcmear, in Holland, the inventor of telescopes with glasses, one of which he presented to the States General in 1609. Tubes extended, by uniting them, to a great length, were known to the ancients; but Metius was the first who added glasses, and he was indebted to chance for the discovery: he had frequently observed some school-boys playing upon the ice, who made use of their co-

Method  
||  
Metius.

**Metopopolis.** py books rolled up in the shape of tubes, to look at each other, to which they sometimes added pieces of ice at each end, to view distant objects: this led him to the invention of optic glasses.

**METO**, a famous mathematician of Athens, 432 B. C. published his *Anaëdecatortide*, that is, his Cycle of Nineteen years, by which he endeavoured to adjust the course of the sun to that of the moon, and to make the solar and lunar years begin at the same point of time. See *CYCLE of the Moon*.

**METONYMY**, in rhetoric, is a trope in which one name is put for another, on account of the near relation there is between them. See *ORATORY*, n° 51.

**METOPE**, in architecture, is the interval, or square space between the triglyphs of the Doric frieze, which among the ancients used to be painted or adorned with carved work, representing the heads of oxen, or utensils used in sacrifices.

**METOPOSCOPY**, the pretended art of knowing a person's dispositions and manners, by viewing the traces and lines in the face. Ciro Spontoni, who has wrote expressly on metoposcopy, says, that seven lines are examined in the forehead, and that each line is considered as having its particular planet: the first is the line of Saturn, the second of Jupiter, the third of Mars, &c. Metoposcopy is only a branch of physiognomy, which sounds its conjectures on all the parts of the body.

**METRE**, *μετρον*, in poetry, a system of feet of a just length.

The different metres in poetry, are the different manners of ordering and combining the quantities, or the long and short syllables: thus hexameter, pentameter, iambic, sapphic verses, &c. consist of different metres, or measures. See *HEXAMETER*.

In English verses, the metres are extremely various and arbitrary, every poet being at liberty to introduce any new form that he pleases. The most usual are the heroic, generally consisting of five long and five short syllables, and verses of four feet, and of three feet, and a caesura, or single syllable.

The ancients, by variously combining and transposing their quantities, made a vast variety of different measures, by forming spondees, &c. of different feet. See *POETRY*, n° 124, &c.

**METRODORUS**, a Greek physician, born at Chios, was the disciple of Democritus the philosopher, and the master of Hippocrates the physician and Anaxarchus the philosopher. He maintained, that the universe is infinite and eternal: but his works are lost. He lived about 444 B. C.

**METROPOLIS**, the capital or principal city of a country or province.

The term *metropolis* is also applied to archiepiscopal churches, and sometimes to the principal or mother-church of a city. The Roman empire having been divided into 13 dioceses and 120 provinces, each diocese and each province had its metropolis, or capital city, where the proconsul had his residence. To this civil division, the ecclesiastical was afterwards adapted, and the bishop of the capital city had the direction of affairs, and the preeminence over all the bishops of the province. His residence in the metropolis gave him the title of *metropolitan*. This erection of metropolitans is referred to the end of the third century, and

was confirmed by the council of Nice. A metropolitan has the privilege of ordaining his suffragans; and appeals from sentences passed by the suffragans are preferred to the metropolitan.

**METZ**, an ancient, large, and strong town of France, and capital of the territory of Meffin, with a citadel, a parliament, and a bishop's see, whose bishop assumes the title of a *prince of the empire*. The cathedral church is one of the finest in Europe, and the square called *Coffin*, and the house of the governor, are worth seeing. The Jews live in a part of the town by themselves, where they have a synagogue. The sweetmeats they make here are in high esteem. It is seated at the confluence of the rivers Moselle and Seille. E. Long. 6. 16. N. Lat. 49. 7.

**MEURSIUS** (John), a learned and laborious writer, born at Lofdun, near the Hague, in 1579. He early discovered a fondness for polite literature and the sciences; and went to study the law at Orleans with the son of Barneveldt, whom he accompanied in his travels. In 1610 he was made professor of history at Leyden, and afterwards Greek professor. His reputation daily increasing, Christian IV. king of Denmark made him professor of history and politics, in the university of Sora. Meursius filled that chair with universal applause; and died in 1641, aged 62. He wrote many learned works, several of which relate to the ancient state of Greece; as, 1. *De populis Atticæ*. 2. *Atticarum lectionum libri vi*. 3. *Archontes Athenienses*. 4. *Fortuna Atticæ*. 5. *De Atheniarum origine*. 6. *De festis Græcorum*, &c. John Meursius, his son, was also the author of several works. It seems almost needless to observe, that the scandalous obscene Latin work, intitled *Meursius*, is not either of our author or his son; but, as is said, the notable production of one John Weltranus, a lawyer at the Hague.

**MEW**, *SEA-MEW*, or *Sea-mall*. See *ANAS*.

*Winter-MEW*, or *Coddy-maddy*, in ornithology. See *LARUS*.

**MEWING**, the falling off or change of hair, feathers, skin, horns, or other parts of animals, which happens in some annually, in others only at certain stages of their lives: but the generality of beasts mew in the spring. An old hart calts his horns sooner than a young one, which is commonly in the months of February and March, after which they begin to button in March or April: and as the sun grows strong, and the season of the year puts forth the fruits of the earth, so their heads grow, and are summed full by the middle of June. It is to be observed, that if a hart be gelt before he has a head, he will never have any; and if he be gelt after he has a head, he will never cast his horns; again, if he be gelt when he has a velvet-head, it will always be so, without fraying, or burnishing.

**MEXICO**, otherwise called *New-Spain*; a large country of America, bounded on the north by New-Mexico, on the east by the gulf of Mexico and the North Sea, and on the south and west by South America and the South Sea; extending upwards of 2000 miles in length, and from 60 to 600 in breadth.

This country was first discovered, though imperfectly, by a Spaniard named *Nunez de Balboa*; but, in December by 1518, the conquest of it was undertaken by a celebrated adventurer named *Ferdinando Cortes*. It was not,

Metz || Mexico.

Conquest of Mexico undertaken by Cortes.

Mexico.

however, without great difficulty that he got his expedition set on foot; being persecuted by the Spanish governors in the West Indies, so that he was at last obliged to throw off his allegiance to them, and proceed without any commission. However, on the 10th of February 1519, he set sail from the Havannah in Cuba; and soon landed on the island of Cozumel, on the coast of Yucatan, discovered the preceding year. Here he joined one of his officers named *Pedro d'Alvarez*, who had arrived some days before, and collected some booty and taken a few prisoners. But the general severely censured his conduct; and the prisoners were dismissed, after they had been informed by an Indian interpreter named *Melchior*, that such injuries were entirely disagreeable to the intentions and wishes of Cortes. Here he mustered his army, and found that it amounted to 508 soldiers, 16 horsemen, and 109 mechanics, pilots, and mariners. Having encouraged his men by a proper speech, and released, by means of some Indian ambassadors, a Spaniard named *Ferom de Aguilar*, who had been detained a prisoner for eight years, he proceeded to the river Tabasco, where he hoped to be received in a friendly manner, as one Grijalva had been a short time before; but, from some unkind cause, he was violently attacked by them: however, the superiority of the Spanish arms soon decided the victory, and the inhabitants were obliged to own the king of Castile as their sovereign.

2  
Receives an  
embassy  
from the  
emperor of  
Mexico.

The Spaniards then continued their course westward, to the harbour of St Juan de Ullua; where they were met by two Mexican canoes, who carried two ambassadors from the emperor of that country, and shewed the greatest signs of peace and amity. Their language was unknown to Aguilar; but one of the female slaves above-mentioned understood it, and translated it into the Yucatan tongue; after which Aguilar interpreted the meaning in Spanish. This slave was afterwards named *Donna Marina*, and proved very useful in their conferences with the natives.

3  
State of the  
empire at  
that time.

At this time the Mexican empire, according to Dr Robertson, was arrived at a pitch of grandeur to which no society had ever attained in so short a period. Though it had subsisted only for 130 years, its dominion extended from the north to south sea; over territories stretching about 500 leagues from east to west, and more than 200 from north to south; comprehending provinces not inferior in fertility, population, and opulence, to any in the torrid zone. The reigning emperor was called Montezuma, or *Moteczuma*, whose authority was very despotic, and his temper haughty and cruel. Though by nature he possessed a good deal of courage and resolution; yet from the first moment that the Spaniards appeared on his coast, he discovered symptoms of timidity and embarrassment, and all his subjects were embarrassed as well as himself. The general dismay which took place on this occasion was partly owing to the strange figure the Spaniards made, and the prodigious power of their arms; but partly also to the following circumstance. An opinion prevailed almost universally among the Americans, if we may believe the earliest and most authentic historians, that some dreadful calamity impended over their heads, from a race of formidable invaders who should come from regions towards the rising sun, to over-run and desolate their country. Whether this disquieting apprehension flowed from the memory of

Mexico.

some natural calamity which had afflicted that part of the globe, and impressed the minds of the inhabitants with superstitious fears and forebodings; or whether it was an imagination accidentally suggested by the astonishment which the first sight of a race of new men occasioned, it is impossible to determine. But as the Mexicans were more prone to superstition than any people in the new world, they were more deeply affected with the appearance of the Spaniards, whom they instantly supposed to be the instruments destined to bring about that fatal revolution which they dreaded: and this produced the embassy above-mentioned.

By means of his two interpreters, Donna Marina, and Aguilar, Cortes learned that the chiefs of the Mexican embassy were deputies from Pilpatoc and Teutile; the one governor of a province under the emperor, and the other the commander of all his forces in that province: the purport of their embassy was, to inquire what his intentions were in visiting their coasts, and to offer him what assistance he might need in order to continue his voyage. Cortes, in his turn, also professed the greatest friendship; and informed the ambassadors, that he came to propose matters of the utmost consequence to the welfare of the prince and his kingdom; which he would more fully unfold in person to the governor and the general. Next morning, without waiting for any answer, he landed his troops, his horses, and his artillery; began to erect huts for his men, and to fortify his camp. The natives, instead of opposing the entrance of these fatal guests into their country, assisted them in all their operations, with an alacrity which they had ere long reason to repent.

4  
Cortes lands  
and fortifies  
his camp.

The next day the ambassadors had a formal audience; at which Cortes acquainted them, that he came from Don Carlos of Austria, king of Castile, the greatest monarch of the east, and was intrusted with propositions of such moment, that he would impart them to none but the emperor himself, and therefore required to be conducted immediately to the capital. This demand immediately produced the greatest uneasiness; and the ambassadors did all in their power to dissuade Cortes from his design, endeavouring to conciliate his good-will by the presents sent him by Montezuma. These they introduced with great parade, and consisted of fine cotton-cloth, of plumes of various colours, and of ornaments of gold and silver to a considerable value, the workmanship of which appeared to be as curious as the materials were rich. But these presents served only to excite the avidity of the Spaniards, and to increase their desire for becoming masters of a country which abounded with so many precious commodities. Cortes indeed could scarcely restrain himself so far as to hear the arguments made use of by the ambassadors to dissuade him from going to the capital; and, in a haughty, determined tone, insisted on his former demand of being admitted to a personal interview with his sovereign.

5  
The Indians  
endeavour  
to dissuade  
him from  
going to  
the capital,  
but in vain.

During this conversation, some painters in the retinue of the Mexican chiefs had been diligently employed in delineating, upon white cotton cloths, figures of the ships, horses, artillery, soldiers, and whatever else attracted their eyes as singular. When Cortes observed this, and was informed that these pictures were to be sent to Montezuma, he resolved to render the representation still more striking and interesting. The trumpets, by his orders, sounded an alarm; the

troops.

Mexico. troops formed in order of battle, and shewed their agility and strength in the best manner they could; while the artillery was pointed against the neighbouring trees, among which it made dreadful havoc. The Indians for some time looked on with silent astonishment; but at the explosion of the cannon, some fled, others fell to the ground, and all were so confounded, that Cortes found it difficult to quiet and compose their minds.

6 Montezuma made acquainted with his design. When the painters had exerted their utmost efforts in representing all these wonderful things, messengers were immediately dispatched to Montezuma with the pictures, and a full account of every thing that had passed since the arrival of the Spaniards, together with some European curiosities to Montezuma; which, though of no great value, Cortes believed would be acceptable on account of their novelty. The Mexican monarchs, in order to obtain the earliest information of every occurrence in all parts of their empire, had couriers posted at proper stations along the principal roads; and as these were trained to agility by a regular education, they conveyed intelligence with surprising rapidity. Though the city in which Montezuma resided was above 180 miles from St Juan de Ullua, Cortes's presents were carried thither, and an answer returned to his demands, in a few days.

7 As the answer was unfavourable, Montezuma had endeavoured to mollify the Spanish general by the richness of his presents. These consisted of the manufactures of the country; cotton-stuffs so fine, and of such delicate texture, as to resemble silk; pictures of animals, trees, and other natural objects, formed with feathers of different colours, disposed and mingled with such skill and elegance as to rival the works of the pencil in truth and beauty of imitation. But what chiefly attracted their attention, were two large plates of a circular form; one of massive gold representing the sun, the other of silver representing the moon. These were accompanied with bracelets, collars, rings, and other trinkets of gold; and that nothing might be wanting which could give the Spaniards a complete idea of what the country afforded, some boxes filled with pearls, precious stones, and grains of gold unwrought, as they had been found in the mines or rivers, were sent along with the rest. Cortes received all with an appearance of the most profound respect for Montezuma; but when the Mexicans, presuming upon this, informed him, that their master, though he desired him to accept of what he had sent as a token of his regard for the prince whom he represented, would not give his consent that foreign troops should approach nearer to his capital, or even allow them to continue longer in his dominions. Cortes declared, in a manner more resolute and peremptory than formerly, that he must insist on his first demand; as he could not, without dishonour, return to his own sovereign until he was admitted into the presence of the prince whom he was appointed to visit in his name. The Mexicans were astonished at the sight of a man who dared to oppose the will of their emperor; but not being willing to come to an open rupture with such formidable enemies, with much ado they prevailed upon Cortes to promise that he would not move from his present camp until the return of a messenger whom they sent to Montezuma for further instructions.

8 Cortes still insists on his demand. The pusillanimity of the Indian monarch afforded

time to the Spaniards to take measures which would have been out of their power had they been vigorously attacked on their first refusal to obey his orders. Cortes used every method of securing the affections of the soldiers; which indeed was very necessary, as many of them began to exclaim against the rashness of his attempt in leading them against the whole force of the Mexican empire. In a short time Teutle arrived with another present from Montezuma, and together with it delivered the ultimate orders of that monarch to depart instantly out of his dominions; and when Cortes, instead of complying with his demands, renewed his request of audience, the Mexican immediately left the camp with strong marks of surpris and resentment. Next morning, none of the natives appeared; all friendly correspondence seemed to be at an end, and hostilities were expected to commence every moment. A sudden consternation ensued among the Spaniards, and a party was formed against him by the adherents of Velasquez; who took advantage of the occasion, and deputed one of their number, a principal officer, to remonstrate, as if in name of the whole army, against his rashness, and to urge the necessity of his returning to Cuba. Cortes received the message without any appearance of emotion; and as he well knew the temper and wishes of his soldiery, and foresaw how they would receive a proposition so fatal to all the splendid hopes and schemes which they had been forming with such complacency, he pretended to comply with the request now made him, and issued orders that the army should be in readiness next day to embark for Cuba. Upon hearing this, the troops, as Cortes had expected, were quite outrageous: they positively refused to comply with these orders, and threatened immediately to choose another general if Cortes continued to insist on their departure.

9 Montezuma peremptorily commands him to leave his dominions. Our adventurer was highly pleased with the disposition which now appeared among his troops: nevertheless, dissembling his sentiments, he declared, that his orders for embarking had proceeded from a persuasion that it was agreeable to his fellow-soldiers, to whose opinion he had sacrificed his own; but now he acknowledged his error, and was ready to renew his original plan of operation. This speech was highly applauded; and Cortes, without allowing his men time to cool, set about carrying his designs into execution. In order to give a beginning to a colony, he assembled the principal persons in his army, and by their suffrages elected a council and magistrates, in whom the government was to be vested. The persons chosen were most firmly attached to Cortes; and the new settlement had the name of *Villa Rica de la vera Cruz*; that is, the rich town of the true cross.

10 Villa Rica is founded. Before this court of his own making, Cortes did not hesitate at resigning all his authority, and was immediately re-elected chief-justice of the colony. The government of the new colony vested in Cortes. The soldiers eagerly ratified their choice by loud acclamations; and Cortes, now considering himself as no longer accountable to any subject, began to assume a much greater degree of dignity, and to exercise more extensive powers, than he had done before. Some of the soldiers began to exclaim against the proceedings of the council as illegal; but the ringleaders were in

Mexico.

11

12

Mexico. flantly sent on board the fleet loaded with irons. By this timely severity the rest were overawed; and Cortes, knowing of how great importance unanimity was to his future success, soon found means to reconcile those who were most disaffected; to which purpose a liberal distribution of the Mexican gold, both among friends and foes, contributed not a little.

11  
Makes an alliance with the Cacique of Zempoalla.

Cortes, having thus strengthened himself as well as he could, resolved to advance into the country; and to this he was encouraged by the behaviour of the cacique or petty prince of Zempoalla, a considerable town at no great distance. This prince, though subject to Montezuma, was exceedingly impatient of the yoke; and so filled with dread and hatred of the emperor, that nothing could be more acceptable to him than an appearance of being delivered from that subjection; and a deliverance of this kind he now hoped from the Spaniards. For this reason he sent ambassadors to Cortes, with offers of friendship, which were gladly accepted by him; and in consequence of the alliance, he very soon visited Zempoalla. Here he was received in the most friendly manner imaginable, and had a respect paid towards him almost equivalent to adoration. The cacique informed him of many particulars relating to the character of Montezuma.— He told him, that he was a tyrant, haughty, cruel, and suspicious; who treated his own subjects with arrogance, ruined the conquered provinces by his extortions, and often tore their sons and daughters from them by violence; the former to be offered as victims to his gods, the latter to be reserved as concubines for himself and favourites. Cortes, in reply, artfully insinuated, that one great object of the Spaniards in visiting a country so remote from their own was, to redress grievances, and to relieve the oppressed; and having encouraged him to hope for this interposition in due time, continued his march to Quiabillan, the territory of another cacique, and where, by the friendly aid of the Indians, a Spanish colony was soon formed.

12  
Character of Montezuma given by the cacique.

During the residence of Cortes in these parts, he so far wrought on the minds of the caciques of Zempoalla and Quiabillan, that they ventured to insult the Mexican power, at the very name of which they had been formerly accustomed to tremble. Some of Montezuma's officers having appeared to levy the usual tribute, and to demand a certain number of human victims, as an expiation of their guilt in presuming to hold intercourse with those strangers whom the emperor had commanded to leave his dominions; instead of obeying his orders, they made them prisoners, treated them with great indignity, and, as their superstition was no less barbarous than Montezuma's, they threatened to sacrifice them to their gods. From this last danger, however, they were delivered by the interposition of Cortes, who manifested the utmost horror at the mention of such a deed. This act of rebellion firmly attached the two caciques to the interest of Cortes; and without hesitation they acknowledged themselves vassals of the king of Spain. Their example was followed by the Totonagues, a fierce people who inhabited the mountainous parts of the country. They willingly subjected themselves to the crown of Castile; and offered

13  
The caciques of Zempoalla, Quiabillan, and some others, submit.

towards Mexico. to accompany Cortes with all their forces in his march towards Mexico.

Though Cortes had now taken such measures as in a manner ensured his success; yet, as he had thrown off all dependence on the governor of Cuba, who was his lawful superior, and apprehended his interest at court, he thought proper, before he set out on his intended expedition, to take the most effectual measures against the impending danger. With this view, he persuaded the magistrates of his colony to address a letter to the king, containing a pompous account of their own services, of the country they had discovered, &c. and of the motives which had induced them to throw off their allegiance to the governor of Cuba, and to settle a colony dependent on the crown alone, in which the supreme power civil as well as military had been vested in Cortes; humbly requesting their sovereign to ratify what had been done by his royal authority. Cortes himself wrote in a similar strain; but as he knew that the Spanish court, accustomed to the repeated exaggerations of American adventurers, would give little credit to the splendid accounts of New-Spain, if they were not accompanied with such a specimen of what it contained as would excite an high idea of its opulence, he solicited his soldiers to relinquish what they might claim as their part of the treasures which had hitherto been collected, in order that the whole might be sent to the king. Portocarrero and Montejo, the chief magistrates of the colony, were appointed to carry this present to Castile, with express orders not to touch at Cuba in their passage thither. But while a vessel was preparing for their departure, an unexpected event produced a general alarm. Some soldiers and sailors, secretly disaffected to Cortes, formed a design of seizing one of the brigantines, and making their escape to Cuba, in order to give such intelligence to the governor, as might enable him to intercept the vessel which was to carry the treasure and dispatches to Spain. This conspiracy was conducted with profound secrecy; but at the moment when every thing was ready for execution, the secret was discovered by one of the associates. The latent spirit of disaffection which Cortes was now too well convinced had not been extinguished amongst his troops, gave him very great uneasiness. The only method which he could think of to prevent such conspiracies for the future was, to destroy his fleet; and thus deprive his soldiers of every resource except that of conquest: and with this proposal he persuaded his men to comply. With universal consent therefore the ships were drawn ashore, and, after being stripped of their sails, rigging, iron-work, and whatever else might be of use, they were broke in pieces.

14  
The magistrates of Villa Rica send a letter to the king of Spain in favour of Cortes.

15  
Cortes burns his fleet.

Cortes having thus rendered it necessary for his troops to follow wherever he chose to lead, began his march from Zempoalla with 500 infantry, 15 horse, and six field-pieces. The rest of his troops, consisting chiefly of such as from age or infirmity were less fit for active service, he left as a garrison in Villa Rica, under the command of Escalante, an officer of merit, and warmly attached to his interest. The cacique of Zempoalla supplied him with provisions; and with 200 of those Indians called *Tanames*, whose office, in a country where tame animals were unknown, was to carry

Mexico. carry burdens, and perform all manner of servile labour. He offered likewise a considerable body of troops; but Cortes was satisfied with 400; taking care, however, to choose persons of such note, that they might serve as hostages for the fidelity of their master.

16  
Sends am-  
bassadors to  
the republic  
of Tlalcala.

Nothing memorable happened till the Spaniards arrived on the confines of the republic of Tlalcala. The inhabitants of that province were warlike, fierce, and revengeful, and had made considerable progress in agriculture and some other arts. They were implacable enemies to Montezuma; and therefore Cortes hoped that it would be an easy matter for him to procure their friendship. With this view, four Zem-poallans of high rank were sent ambassadors to Tlalcala, dressed with all the badges of that office usual among the Indians. The senate were divided in their opinions with regard to the proposals of Cortes: but at last, Magificatzin, one of the oldest senators, and a person of great authority, mentioned the tradition of their ancestors, and the revelations of their priests; that a race of invincible men, of divine origin, who had power over the elements, should come from the east to subdue their country. He compared the resemblance which the strangers bore to the persons figured in the tradition of Mexico, their dominion over the elements of fire, air, and water; he reminded the senate of their prodigies, omens, and signals, which had lately terrified the Mexicans, and indicated some very important event; and then declared his opinion, that it would be rashness to oppose a force apparently assisted by heaven, and men who had already proved, to the sad experience of those who opposed them, that they were invincible. This orator was opposed by Xicotencal, who endeavoured to prove that the Spaniards were at best but powerful magicians; that they had rendered themselves obnoxious to the gods by pulling down their images and altars, (which indeed Cortes had very imprudently done at Zempoalla); and of consequence, that they might easily be overcome, as the gods would not fail to resent such an outrage. He therefore voted for war, and advised the crushing of these invaders at one blow.

17  
The Tlalcalans re-  
solve on  
war.

The advice of Xicotencal prevailed; and in consequence of it, the ambassadors were detained; which giving Cortes the alarm, he drew nearer the city of Tlalcala. In this transaction we may easily see how little the Tlalcalans, notwithstanding all their ferocity, were skilled in military affairs. They suffered Cortes, with his army drawn up in good order, to pass a strong wall between two mountains, which might have been very advantageously defended against him. He had not advanced far beyond this pass, however, before a party of Tlalcalans with plumes were discovered, which denoted that an army was in the field. These he drove before him by a detachment of six horse, obliged them to join another party, and then reinforcing the advanced detachment, charged the enemy with such vigour that they began to retire. Five thousand Tlalcalans, whom Xicotencal had placed in ambush, then rushed out of their hiding places, just as the infantry came up to assist their slender body of cavalry. The enemy attacked with the utmost fury; but were so much disconcerted by the first discharge of the fire-arms,

that they retreated in confusion, furnishing the Spaniards with an opportunity of pursuing them with great slaughter. Cortes, however, supposing that this could not be their whole force, advanced with the utmost caution, in order of battle, to an eminence, from whence he had a view of the main body of the Tlalcalan army commanded by Xicotencal, consisting of no fewer than 40,000 men. By these the small army of Cortes was entirely surrounded; which Xicotencal no sooner perceived, than he contracted the circle with incredible diligence, while the Spaniards were almost overwhelmed with showers of arrows, darts, and stones. It is impossible but in this case many of the Spaniards must have perished, had it not been for the insufficiency of the Indian weapons. Their arrows and spears were headed only with flint, or the bones of fishes; their stakes hardened in the fire, and wooden swords, though destructive weapons among naked Indians, were easily turned aside by the Spanish bucklers, and could hardly penetrate the quilted jackets which the soldiers wore. These circumstances gave the Spaniards a prodigious advantage over them; and therefore, the Tlalcalans notwithstanding their valour and superiority in number, could accomplish no more in the present instance, than to kill one horse, and slightly wound nine soldiers.

The Tlalcalans being taught by this, and some subsequent encounters, how much they were inferior to the Spaniards, began to conceive them to be really what Magificatzin had said; a superior order of beings, against whom human power could not prevail. In this extremity they had recourse to their priests, requiring them to reveal the causes of such extraordinary events, and to declare what means they should take to repel such formidable invaders. The priests, after many sacrifices and incantations, delivered their response. That these strangers were the offspring of the sun, procreated by his animating energy in the regions of the east; that, by day, while cherished with the influence of his parental beams, they were invincible; but by night, when his reviving heat was withdrawn, their vigour declined and faded like herbs in the field, and they dwindled down into mortal men. In consequence of this, the Tlalcalans acted in contradiction to one of their most established maxims in war, and ventured to attack the enemy in the night-time, hoping to destroy them when enfeebled and surprized. But the Spanish sentinels having observed some extraordinary movements among the Tlalcalans, gave the alarm. Immediately the troops were under arms, and falling out, defeated their antagonists with great slaughter, without allowing them to approach the camp. By this defeat after the Tlalcalans were heartily disposed to peace; but they were at a loss to form an adequate idea of the enemies they had to deal with. They could not ascertain the nature of these surprising beings, or whether they were really of a benevolent or malignant disposition. There were circumstances in their behaviour which seemed to favour each opinion. On the one hand, as the Spaniards constantly dimissed the prisoners whom they took, not only without injury, but often with presents of European toys, and renewed their offers of peace after every victory; this lenity amazed people accustomed to the exterminating system of war known in America, and who sacrificed and devoured without mercy all the captives taken in battle;

Mexico.

18  
But are dis-  
satisfied and  
sue for  
peace.

and

Mexico.

and disposed them to entertain sentiments favourable to their humanity. But, on the other hand, as Cortes had seized 50 of their countrymen who brought provisions to their camp, and cut off their heads; this bloody spectacle, added to the terror occasioned by the fire-arms and horses, filled them with dreadful ideas of their ferocity. Accordingly they addressed them in the following manner: "If, (said they), you are divinities of a cruel and savage nature, we present to you five slaves, that you may drink their blood and eat their flesh. If you are mild deities, accept an offering of incense and variegated plumes. If you are men, here is meat, bread, and fruit, to nourish you." After this address, the peace was soon concluded, to the great satisfaction of both parties. The Tlafcalans yielded themselves as vassals to the crown of Castile, and engaged to assist Cortes in all his operations; while he took the republic under his protection, and promised to defend their persons and possessions from injury and violence.

19  
Which is granted.

20  
Great distresses of the Spaniards.

This reconciliation took place at a very seasonable juncture for the Spaniards. They were not only worn out with incessant toil, but so destitute of necessaries, that they had no other salve to dress their wounds but what was composed of the fat of Indians whom they had slain. Their distresses, in short, were arisen to such a height that they had begun to murmur, and even to despair, inasmuch that Cortes had much difficulty in restraining them within any kind of bounds: but the submission of the Tlafcalans, and their own triumphant entry into the city, where they were received with the reverence due to a superior order of beings, banished at once all memory of past sufferings, dispelled every anxious thought, and fully convinced them that they could not be resisted by any power in America.

21  
Cortes commences his march for Mexico.

Cortes left no method untried to gain the favour and confidence of the Tlafcalans; which, however, he had almost entirely lost, by his untimely zeal in destroying their idols as he had done those of Zempoalla. But he was deterred from this rash action by his chaplain, father Bartholomew de Olmedo; and left the Tlafcalans in the undisturbed exercise of their superstition, requiring only that they should desist from their horrid practice of offering human victims. As soon as his troops were fit for service, he resolved to continue his march towards Mexico, notwithstanding the remonstrances of the Tlafcalans, who looked upon his destruction as unavoidable if he put himself into the power of such a faithless prince as Montezuma. But the emperor, probably intimidated with the fame of his exploits, had resolved to admit his visit; and informed Cortes that he had given orders for his friendly reception at Cholula, the next place of any consequence on the road to Mexico. In this, however, he was by no means sincere. Cholula was looked upon by all the inhabitants of the empire as a very holy place; the sanctuary and chief seat of their gods, to which pilgrims resorted from every province, and a greater number of human victims were offered in its principal temple than even in that of Mexico. Montezuma therefore invited the Spaniards thither, either from some superstitious hope that the gods would not suffer this sacred mansion to be defiled; or from a belief, that he himself might there find an opportunity of cutting

22  
Treachery of Montezuma and the Cholulans.

them off with more certainty of success, than under the immediate protection of his gods. Cortes, however, was received with much seeming cordiality; but 6000 Tlafcalan troops who accompanied him were obliged to remain without the town, as the Cholulans refused to admit their ancient enemies within their precincts. Yet two of these, by disguising themselves, got into the city, and acquainted Cortes that they observed the women and children belonging to the principal citizens retiring every night in a great hurry, and that six children had been sacrificed in the great temple; a sign that some warlike enterprise was at hand. At the same time Donna Marina, the interpreter, received information from an Indian woman of distinction, whose confidence she had gained, that the destruction of the Spaniards was concerted; that a body of Mexican troops lay concealed near the town; that some of the streets were barricaded, in others deep pits or trenches were dug, and slightly covered over, as traps into which the horse might fall; that stones and missile weapons were collected on the tops of the temples, with which to overwhelm the infantry; that the fatal hour was already at hand, and their ruin unavoidable. Cortes, alarmed at this news, secretly arrested three of the chief priests, from whom he extorted a confession that confirmed the intelligence he had already received. As not a moment was to be lost, he instantly resolved to prevent his enemies, and to inflict on them such dreadful vengeance as might strike Montezuma and his subjects with terror. For this purpose the Spaniards and Zempoallans were drawn up in a large court, which had been allotted for their quarters, near the centre of the town; the Tlafcalans had orders to advance; the magistrates and chief citizens were sent for under various pretexts, and seized. On a signal given, the troops rushed out, and fell upon the multitude, destitute of leaders, and so much astonished, that the weapons dropped from their hands, and they stood motionless, and incapable of defence. While the Spaniards attacked them in front, the Tlafcalans did the same in the rear; the streets were filled with slaughter; the temples, which afforded a retreat to the priests and some leading men, were set on fire, and they perished in the flames. This scene of horror continued two days; during which the wretched inhabitants suffered all that the destructive rage of the Spaniards, or the implacable revenge of their Indian allies, could inflict. At length the carnage ceased, after the slaughter of 6000 Cholulans, without the loss of a single Spaniard. Cortes then released the magistrates; and reproaching them bitterly for their intended treachery, declared, that as justice was now appeased, he forgave the offence; but required them to recall the inhabitants who had fled, and re-establish order in the town. Such was the ascendant that the Spaniards had now obtained over this superstitious race, that this order was instantly complied with; and the city was in a few days again filled with people, who paid the most respectful service to those men whose hands were stained with the blood of their relations and fellow-citizens.

Mexico.

23  
Severe punishment of the Cholulans.

From Cholula, Cortes advanced directly towards Mexico; and throughout the whole of his journey was of Montezuma's subjects. He was entertained with accounts of the oppressions and cruelty of Montezuma. This gave him the greatest hope of accomplishing his design; as he now perceived that

24  
Disaffection of Montezuma's subjects.



Mexico.

the empire was entirely divided, and no sort of unanimity prevailed among them. No enemy appeared to check his progress. Montezuma was quite irresolute; and Cortes was almost at the gates of the capital, before the emperor had determined whether to receive him as a friend, or oppose him as an enemy. But as no sign of open hostility appeared, the Spaniards, without regarding the fluctuations of Montezuma's sentiments, continued their march to Mexico, with great circumspection and the strictest discipline, though without seeming to suspect the prince whom they were about to visit.

35  
Meeting of  
Cortes and  
Montezuma.

When they drew near the city, about 1000 persons, who appeared to be of distinction, came forth to meet them, adorned with plumes, and clad in mantles of fine cotton. Each of these, in his order, passed by Cortes, and saluted him according to the mode deemed most respectful and submissive in their country. They announced the approach of Montezuma himself, and soon after his harbingers came in sight. There appeared first 200 persons in a uniform dress, with large plumes of feathers, alike in fashion, marching two and two, in deep silence, barefooted, with their eyes fixed on the ground. These were followed by a company of higher rank, in their most showy apparel; in the midst of whom was Montezuma, in a chair or litter richly ornamented with gold, and feathers of various colours. Four of his principal favourites carried him on their shoulders, others supported a canopy of curious workmanship over his head. Before him marched three officers with rods of gold in their hands, which they lifted up on high at certain intervals; and at that signal all the people bowed their heads, and hid their faces, as unworthy to look on so great a monarch. When he drew near, Cortes dismounted, advancing towards him with officious haste, and in a respectful posture. At the same time Montezuma alighted from his chair, and leaning on the arms of two of his near relations, approached with a slow and stately pace, his attendants covering the street with cotton cloths, that he might not touch the ground. Cortes accosted him with profound reverence, after the European fashion. He returned the salutation, according to the mode of his country, by touching the earth with his hand, and then kissing it. This ceremony, the customary expression of reverence from inferiors towards those who are above them in rank, appeared such amazing condescension in a proud monarch, who scarcely deigned to consider the rest of mankind as of the same species with himself, that all his subjects firmly believed those persons, before whom he humbled himself in this manner, to be something more than human. Accordingly, as they marched through the crowd, the Spaniards frequently, and with much satisfaction, heard themselves denominated *teules*, or *divinities*. Nothing material passed in this first interview. Montezuma conducted Cortes to the quarters which he had prepared for his reception; and immediately took leave of him, with a politeness not unworthy of a court more refined. "You are now, (says he), with your brothers, in your own house; refresh yourselves after your fatigue, and be happy until I return." The place allotted to the Spaniards for their lodging was a house built by the father of Montezuma. It was surrounded by a stone-wall, with towers at proper distances, which fer-

Mexico.

ved for defence as well for ornament; and its apartments and courts were so large as to accommodate both the Spaniards and their Indian allies. The first care of Cortes was to take precautions for his security, by planting the artillery so as to command the different avenues which led to it, by appointing a large division of his troops to be always on guard, and by posting centinels at proper stations, with injunctions to observe the same vigilant discipline as if they were within sight of an enemy's camp.

In the evening Montezuma returned to visit his guests with the same pomp as in their first interview; and brought presents of such value, not only to Cortes and to his officers, but even to the private men, as proved the liberality of the monarch to be suitable to the opulence of his kingdom. A long conference ensued, in which Cortes learned what was the opinion of Montezuma with respect to the Spaniards. It was an established tradition, he told him, among the Mexicans, that their ancestors came originally from a remote region, and conquered the provinces now subject to his dominion; that after they were settled there, the great captain who conducted this colony returned to his own country, promising, that at some future period his descendants should visit them, assume the government, and reform their constitutions and laws; that, from what he had heard and seen of Cortes and his followers, he was convinced that they were the very persons whose appearance and prophecies taught them to expect; that accordingly he had received them, not as strangers, but as relations of the same blood and parentage, and desired that they might consider themselves as masters in his dominions; for both himself and his subjects should be ready to comply with their will, and even to prevent their wishes. Cortes made a reply in his usual style with respect to the dignity and power of his sovereign, and his intention in sending him into that country; artfully endeavouring so to frame his discourse, that it might coincide as much as possible with the idea which Montezuma had formed concerning the origin of the Spaniards. Next morning, Cortes and some of his principal attendants were admitted to a public audience of the emperor. The three subsequent days were employed in viewing the city; the appearance of which, so far superior in the order of its buildings and the number of its inhabitants to any place the Spaniards had beheld in America, and yet so little resembling the structure of an European city, filled them with surpris and admiration.

Mexico, *Tenochtitlan*, as it was anciently called by the natives, is situated in a large plain, environed by mountains of such height, that though within the torrid zone, the temperature of its climate is mild and healthful. All the moisture which descends from the high grounds is collected in several lakes, the two largest of which, of about 90 miles in circuit, communicate with each other. The waters of the one are fresh, those of the others brackish. On the banks of the latter, and on some small islands adjoining to them, the capital of Montezuma's empire was built. The access to the city was by artificial causeways or streets, formed of stones and earth, about 30 feet in breadth. As the waters of the lake, during the rainy season, overflowed the flat country, these causeways were of

26  
Description  
of the city  
of Mexico.

con-

Mexico, considerable length. That of Tacuba on the west a mile and a half; that of Tezucou on the north-west three miles; that of Cuoyacan towards the south six miles. On the east there was no causeway, and the city could be approached only by canoes. In each of these causeways were openings, at proper intervals, through which the waters flowed; and over these beams of timber were laid, which being covered with earth, the causeway or street had every where an uniform appearance. As the approaches to the city were singular, its construction was remarkable. Not only the temple of their gods, but the houses belonging to the monarch and to persons of distinction, were of such dimensions, that, in comparison with any other buildings which had been discovered in America, they might be termed *magnificent*. The habitations of the common people were mean, resembling the huts of other Indians. But they were all placed in a regular manner, on the banks of the canals which passed thro' the city, in some of its districts, or on the sides of the streets which intersected it in other quarters. In several places were large openings or squares, one of which, allotted for the great market, is said to have been so spacious, that 40,000 or 50,000 persons carried on traffic there. In this city, the pride of the New World, and the noblest monument of the industry and art of man, while unacquainted with the use of iron, and destitute of aid from any domestic animal, the Spaniards, who are most moderate in their computations, reckon that there were at least 60,000 inhabitants.

27  
Unconsciousness  
of the Spaniards.

But how much soever the novelty of those objects might amuse or astonish the Spaniards, they felt the utmost solicitude with respect to their own situation. From a concurrence of circumstances, no less unexpected than favourable to their progress, they had been allowed to penetrate into the heart of a powerful kingdom, and were now lodged in its capital, without having once met with open opposition from its monarch. The Tlascalans, however, had earnestly dissuaded them from placing such confidence in Montezuma as to enter a city of such a peculiar situation as Mexico, where that prince would have them at mercy, shut up as it were in a snare, from which it was impossible to escape. They assured him that the Mexican priests had, in the name of the gods, counselled their sovereign to admit the strangers into the capital, that he might cut them off there at one blow with perfect security. The Spaniards now perceived, too plainly, that the apprehensions of their allies were not destitute of foundation; that, by breaking the bridges placed at certain intervals on the causeways, or by destroying part of the causeways themselves, their retreat would be rendered impracticable; and they must remain cooped up in the centre of a hostile city, surrounded by multitudes sufficient to overwhelm them, and without a possibility of receiving aid from their allies. Montezuma had, indeed, received them with distinguished respect. But ought they to reckon upon this as real, or to consider it as feigned? Even if it were sincere, could they promise on its continuance? Their safety depended upon the will of a monarch in whose attachment they had no reason to confide; and an order flowing from his caprice, or a word uttered by him in passion, might decide irrevocably concerning their fate.

These reflections, so obvious as to occur to the meanest soldier, did not escape the vigilant sagacity of their general. Before he set out from Cholula, Cortes had received advice from Villa Rica, that Quetzalpopoca, one of the Mexican generals on the frontiers, having assembled an army in order to attack some of the people whom the Spaniards had encouraged to throw off the Mexican yoke, Escalante had marched out with part of the garrison to support his allies; that an engagement had ensued, in which, though the Spaniards were victorious, Escalante, with seven of his men, had been mortally wounded, his horse killed, and one Spaniard had been surrounded by the enemy and taken alive; that the head of this unfortunate captive, after being carried in triumph to different cities, in order to convince the people that their invaders were not immortal, had been sent to Mexico. Cortes, though alarmed with this intelligence, as an indication of Montezuma's hostile intentions, had continued his march. But as soon as he entered Mexico, he became sensible, that, from an excess of confidence in the superior valour and discipline of his troops, as well as from the disadvantage of having nothing to guide him in an unknown country but the defective intelligence which he received from people with whom his mode of communication was very imperfect, he had pushed forward into a situation, where it was difficult to continue, and from which it was dangerous to retire. Disgrace, and perhaps ruin, was the certain consequence of attempting the latter. The success of his enterprise depended upon supporting the high opinion which the people of New Spain had formed with respect to the irresistible power of his arms. Upon the first symptom of timidity on his part, their veneration would cease, and Montezuma, whom fear alone restrained at present, would let loose upon him the whole force of his empire. At the same time, he knew that the countenance of his own sovereign was to be obtained only by a series of victories; and that nothing but the merit of extraordinary success could screen his conduct from the censure of irregularity. From all these considerations, it was necessary to maintain his station, and to extricate himself out of the difficulties in which one bold step had involved him, by venturing upon another still bolder. The situation was trying, but his mind was equal to it; and after revolving the matter with deep attention, he fixed upon a plan no less extraordinary than daring. He determined to seize Montezuma in his palace, and carry him a prisoner to the Spanish quarters. From the superstitious veneration of the Mexicans for the person of their monarch, as well as their implicit submission to his will, he hoped, by having Montezuma in his power, to acquire the supreme direction of his affairs; or at least, with such a sacred pledge in his hands, he made no doubt of being secure from any effort of their violence.

This he immediately proposed to his officers. The timid startled at a measure so audacious, and raised objections. The more intelligent and resolute, conscious that it was the only resource in which there appeared any prospect of safety, warmly approved of it, and brought over their companions so cordially to the same opinion, that it was agreed instantly to make the attempt. At his usual hour of visiting Montezuma, Cortes went to the palace, accompanied by Alvarado, Saualvaro,

Mexico. Some hostilities between the Spaniards and Mexi-

29  
Cortes resolves to seize Montezuma in his palace.

Mexico.

Sandoval, Lugo, Velazquez de Leon, and Davila, five of his principal officers, and as many trusty soldiers. Thirty chosen men followed, not in regular order, but fauntering at some distance, as if they had no object but curiosity; small parties were posted at proper intervals, in all the streets leading from the Spanish quarters to the court; and the remainder of his troops, with the Tlascalcan allies, were under arms, ready to fall out on the first alarm. Cortes and his attendants were admitted without suspicion; the Mexicans retiring, as usual, out of respect. He addressed the monarch in a tone very different from that which he had employed in former conferences; reproaching him bitterly as the author of the violent assault made upon the Spaniards by one of his officers, and demanded public reparation for the loss which he had sustained by the death of some of his companions, as well as for the insult offered to the great prince whose servants they were. Montezuma, confounded at this unexpected accusation, and changing colour either from the consciousness of guilt, or from feeling the indignity with which he was treated, asserted his own innocence with great earnestness; and, as a proof of it, gave orders instantly to bring Quallpopoca and his accomplices prisoners to Mexico. Cortes replied, with seeming compliance, that a declaration for respectable left no doubt remaining in his own mind; but that something more was requisite to satisfy his followers, who would never be convinced that Montezuma did not harbour hostile intentions against them, unless, as an evidence of his confidence and attachment, he removed from his own palace and took up his residence in the Spanish quarters, where he should be served and honoured as became a great monarch. The first mention of so strange a proposal bereaved Montezuma of speech, and almost of motion. At length he haughtily answered, "That persons of his rank were not accustomed voluntarily to give up themselves as prisoners; and were he mean enough to do so, his subjects would not permit such an affront to be offered to their sovereign." Cortes, unwilling to employ force, endeavoured alternately to soothe and intimidate him. The altercation became warm; and having continued above three hours, Velazquez de Leon, an impetuous and gallant young man, exclaimed with impatience, "Why waste more time in vain? Let us either seize him instantly, or stab him to the heart." The threatening voice and fierce gestures with which these words were uttered, struck Montezuma. The Spaniards, he was sensible, had now proceeded so far, as left him no hope that they would recede. His own danger was imminent, the necessity unavoidable. He saw both; and abandoning himself to his fate, complied with their request.

30  
The emperor carried to the Spanish quarters.

His officers were called. He communicated to them his resolution. Though astonished and afflicted, they presumed not to question the will of their master, but carried him in silent pomp, all bathed in tears, to the Spanish quarters. When it was known that the strangers were conveying away the emperor, the people broke out into the wildest transports of grief and rage, threatening the Spaniards with immediate destruction, as the punishment justly due to their impious audacity. But as soon as Montezuma appeared with a seeming gaiety of countenance, and waved his hand, the tumult was hushed; and upon his declaring it to be of his own

Vol. VII.

1

Mexico.

choice that he went to reside for some time among his new friends, the multitude, taught to revere every intimation of their sovereign's pleasure, quietly dispersed.

The Spaniards at first pretended to treat Montezuma with great respect; but soon took care to let him know that he was entirely in their power. Cortes wished that the shedding the blood of a Spaniard should appear the most heinous crime that could be committed; and therefore not only took a most exemplary vengeance on those who had been concerned in the affair of Villa Rica, but even put the emperor himself in chains till the execution of the Mexican general was over. By these, and other insults, he at last gained entirely the ascendant over this unhappy monarch; and he took care to improve his opportunity to the utmost. He sent his emissaries into different parts of the kingdom, accompanied with Mexicans of distinction, who might serve both to guide and to protect them. They visited most of the provinces, viewed their soil and productions, surveyed with particular care the districts which yielded gold or silver, pitched upon several places as proper for future colonies, and endeavoured to prepare the minds of the people for submitting to the Spanish yoke: and while they were thus employed, Cortes, in the name and by the authority of Montezuma, degraded some of the principal officers in the empire, whose abilities or independent spirit excited his jealousy; and substituted in their place persons who he imagined would be more obsequious. One thing, however, was still wanting to complete his security. He wished to have such a command of the lake as might ensure a retreat, if, either from levity or disgust, the Mexicans should take arms against him, and break down the bridges or causeways, in order to inclose him in the city. In order to obtain this without giving disgust to the emperor or his court, Cortes artfully inflamed the curiosity of the Indians with accounts of the Spanish shipping, and those floating palaces that moved with such velocity on the water, without the assistance of oars; and when he found that the monarch himself was extremely desirous of seeing such a novelty, he gave him to understand, that nothing was wanting to his gratification besides a few necessities from Vera Cruz, for that he had workmen in his army capable of building such vessels. The bait took with Montezuma; and he gave immediate orders that all his people should assist Cortes in whatever he should direct concerning the shipping. By this means, in a few days, two brigantines were got ready, fully rigged and equipped; and Montezuma was invited on board, to make the first trial of their sailing, of which he could form no idea. Accordingly he embarked for this purpose, and gave orders for a great hunting upon the water, in order that all his people might be diverted with the novelty presented by the Spaniards. On the day appointed, the royal equipage was ready early in the morning; and the lake was covered with a multitude of boats and canoes loaded with people. The Mexicans had augmented the number of their rowers on board the royal barges, with an intention to disgrace the Spanish vessels, which they regarded as clumsy, unwieldy, and heavy. But they were soon undeceived; a fresh gale started up, the brigantines hoisted sail, to the utter astonishment of all the spectators, and soon left all the canoes behind; while the

31  
Cortes rules the empire.

32  
By a pretence, he obtains leave to build two brigantines on the lake.

28 D

monarch

Mexico. monarch exulted in the victory of the Spaniards, without once considering that now he had effectually riveted his own chains.

33 Montezuma owes himself a vassal to the king of Spain. Cortes having obtained this important point, resolved to put the condescension of the emperor to a trial still more severe. He urged Montezuma to acknowledge himself a vassal to the crown of Castile; to hold his crown of him as superior, and to subject his dominions to the payment of an annual tribute. With this requisition, humiliating as it was, Montezuma complied. He called together the chief men of his empire, and, in a solemn harangue, reminded them of the traditions and prophecies which led them to expect the arrival of a people sprung from the same flock with themselves, in order to take possession of the supreme power; he declared his belief that the Spaniards were this promised race; and that therefore he recognized the right of their monarch to govern the Mexican empire, would lay his crown at his feet, and obey him as a tributary. While uttering these words, Montezuma discovered how deeply he was affected in making such a sacrifice. Tears and groans frequently interrupted his discourse. The first mention of such a resolution struck the assembly dumb with astonishment. This was followed by a fullen murmur of sorrow mingled with indignation; which indicated some violent eruption of rage to be near at hand. This Cortes foresaw, and seasonably interposed to prevent it, by declaring that his master had no intention to deprive Montezuma of the royal dignity, or to make any innovation upon the constitution and laws of the Mexican empire. This assurance, added to their dread of the Spanish arms, and the authority of their monarch's example, extorted the consent of the assembly; and the act of submission and homage was executed with all the formalities which the Spaniards pleased to prescribe.

Montezuma, at the request of Cortes, accompanied this profession of fealty and homage with a magnificent present to his new sovereign; and, after his example, his subjects brought in very liberal contributions. The Spaniards then collected all the treasure which had been either voluntarily bestowed upon them at different times by Montezuma, or had been extorted from his people under various pretences; and having melted the gold and silver, the value of these, without including jewels and ornaments of various kinds, which were preserved on account of their curious workmanship, amounted to 600,000 pesos. The soldiers were impatient to have it divided; and Cortes complied with their desire. A fifth of the whole was set apart as the tax due to the king. Another fifth was allowed to Cortes, as commander. The sums advanced by the governor of Cuba, who had originally fitted out the expedition, were then deducted. The remainder was then divided among the army, including the garrison of Vera Cruz, in proportion to their different ranks; and after so many deductions, the share of a private man did not exceed 100 pesos. This sum fell far below their sanguine expectations, that it required all the address, and no small exertions of the liberality of Cortes to prevent an open mutiny. However, he at last restored tranquillity; but had no sooner escaped this danger, than he involved himself, by his imprudent zeal for religion, in one much worse. Montezuma, though often importuned, had obstinately re-

fused to change his religion, or abolish the superstitious rites which had been for such a long time practiced throughout his dominions. This at last transported the Spaniard with such rage, that, in a fall of zeal, he led out his soldiers in order to throw down the idols in the great temple by force. But the priests taking arms in defence of their altars, and the people crowding with great ardour to support them, Cortes's prudence over-ruled his zeal; and induced him to desist from his rash attempt, after dislodging the idols from one of the shrines, and placing in their stead an image of the Virgin Mary.

From this moment the Mexicans began to meditate the expulsion or the destruction of the Spaniards. The priests and leading men held frequent meetings with Montezuma for this purpose. But as any violent attempt might have proved fatal to the captive monarch, it was thought proper first to try more gentle means. Having called Cortes into his presence, he observed, that now, as all the purposes of his embassy were fully accomplished, the gods had declared their will, and the people signified their desire, that he and his followers should instantly depart out of the empire. With this he required them to comply, or unavoidable destruction would fall suddenly on their heads. This unexpected requisition, as well as the manner in which it was delivered, alarmed Cortes. However, he supposed that more might be gained by a feigned compliance than by open resistance; and therefore replied with great composure, that he had already begun to prepare for his return; but as he had destroyed the vessels in which he arrived, some time was requisite for building other ships. This appeared reasonable; and a number of Mexicans were sent to Vera Cruz to cut down timber, and some Spanish carpenters were appointed to superintend the work.

Cortes flattered himself that, during this interval, he might either find means to avert the threatened danger, or receive such reinforcements as would enable him to defend himself. Nine months had now elapsed since Ponce de Leon and Montezuma had failed with his dispatches to Spain; and he daily expected a return with a confirmation of his authority from the king, without which all that he had done served only to mark him out as an object of punishment. While he remained in great anxiety on this account, news were brought that some ships had appeared on the coast. These were imagined by Cortes to be a reinforcement sent him from Spain; but his joy was of short continuance, for a courier very soon arrived from Vera Cruz, with certain information that the armament was fitted out by Velasquez, the governor of Cuba; and instead of bringing succours, threatened them with immediate destruction.

Velasquez had been excited to this hostile measure chiefly through the indiscretion, or rather treachery, of the messengers of Cortes; who, contrary to his express injunctions, had landed on the island of Cuba, and given intelligence of all that had passed; and Velasquez, transported with rage at hearing of the proceedings of Cortes, had now sent against him this armament; consisting of 8 ships, which carried 80 horsemen, 800 infantry, of which 80 were musketeers, and 120 cross-bowmen, commanded by a brave officer named *Panphilo de Narvaez*; whose instructions were, to seize Cortes and his principal officers, to send them prisoners

Mexico,

Cortes attempts to destroy the Mexican idols.

36 Which produces a general disaffection.

37 The Spaniards are commanded to depart.

38 An armament sent from Cuba against Cortes.

34 The Spaniards divide their treasure.

Mexico. prisoners to him, and then to complete the discovery and conquest of the country in his name. This proved a most afflicting piece of news to Cortes. However, thinking it imprudent to attempt any thing against his countrymen at first by force, he sent his chaplain, Olmedo, with proposals of accommodation. Narvaez rejected his proposals with scorn; but his followers were less violent in their resentments. Olmedo delivered many letters to them, either from Cortes himself, or from his officers, their ancient friends and companions. These Cortes had artfully accompanied with presents of rings, chains of gold, and other trinkets of value; which inspired those needy adventurers with high ideas of the wealth he had acquired, and with envy of the good fortune of those who were engaged in his service. Some, from hopes of becoming sharers in these rich spoils, declared for an immediate accommodation; while others were for the same pacific measure, through fear of subverting the Spanish power entirely in a country where it was so imperfectly established. Narvaez disregarded both; and, by a proclamation, denounced Cortes and his adherents rebels, and enemies to their country.

39  
Which is  
defeated  
by that  
general.

Cortes having now no resource but in war, left 150 men under the command of Pedro de Alvarado, an officer of great bravery, and much respected by the Mexicans, to guard the capital, and the captive emperor; while he himself marched with the remainder to meet his formidable opponent, who had taken possession of Zempoalla. Even after being reinforced by Sandoval his governor of Vera Cruz, the force of Cortes did not exceed 250 men. He hoped for success chiefly from the rapidity of his motions and the possibility of surprising his enemies; and as he chiefly dreaded the cavalry, he armed his soldiers with long spears; accustoming them to that deep and compact arrangement which the use of this formidable weapon enabled them to assume. As he advanced, however, he repeated his proposals of accommodation; but these being constantly rejected, and a price set upon his head, he at last attacked Narvaez in the night-time, entirely defeated and took him prisoner, obliging all his troops to own allegiance to himself.

Nothing could be more seasonable than this victory, by which Cortes found his army very considerably increased; for most of the soldiers of Narvaez chose rather to follow Cortes than to return to Cuba, whither the conqueror had offered to send them if they chose. His affairs at Mexico, in the mean time, were in the utmost danger of being totally ruined; and had this decisive victory been delayed but a few days longer, he must have come too late to save his companions. A short time after the defeat of Narvaez, a courier arrived from Mexico with the disagreeable intelligence that the Mexicans had taken arms; and having seized and destroyed the two brigantines which he had built in order to secure the command of the lake, had attacked the Spaniards in their quarters, killed some, and wounded many more, burnt their magazine of provisions, and, in short, carried on hostilities with such fury, that though Alvarado and his men defended themselves with undaunted resolution, they must either be cut off by famine, or sink under the multitude of their enemies. This revolt was excited by motives which rendered it still

40  
Dangerous  
situation of  
the Spa-  
niards left  
in Mexi-  
co.

more alarming. On the departure of Cortes for Zempoalla, the Mexicans flattered themselves, that the long-expected opportunity of restoring their sovereignty to liberty, and driving out the Spaniards, was arrived; and consultations were accordingly held for bringing about both these events. The Spaniards in Mexico, conscious of their own weakness, suspected and dreaded these machinations; but Alvarado, who had neither the prudence nor the address of Cortes, took the worst method imaginable to overcome them. Instead of attempting to soothe or cajole the Mexicans, he waited the return of one of their solemn festivals, when the principal persons in the empire were dancing, according to custom, in the court of the great temple; he seized all the avenues which led to it; and, allured partly by the rich ornaments which they wore in honour of their gods, and partly by the facility of cutting off at once the authors of that conspiracy which he dreaded, he fell upon them, unarmed and unsuspecting of danger, and massacred a great number; none escaping, but such as made their way over the battlements of the temple. An action so cruel and treacherous filled not only the city, but the whole empire, with indignation and rage; and the Mexicans immediately proceeded in the manner above-mentioned.

41  
Cortes al-  
lowed re-  
turn to  
Mexico.

Cortes advanced with the utmost celerity to the relief of his distressed companions; but as he passed along, had the mortification to find that the Spaniards were generally held in abhorrence. The principal inhabitants had deserted the towns through which he passed; no person of note appeared to meet him with the usual respect, nor were provisions brought to his camp as usual. Notwithstanding these signs of averision and horror, however, the Mexicans were so ignorant of the military art, that they again permitted him to enter the capital without opposition; though it was in their power to have easily prevented him, by breaking down the bridges and causeways which led to it.

Cortes was received by his companions with the utmost joy; and this extraordinary success so far intoxicated the general himself, that he not only neglected to visit Montezuma, but expressed himself very contemptuously concerning him. These expressions being reported among the Mexicans, they all at once flew to arms, and made such a violent and sudden attack, that all the valour and skill of Cortes were scarce sufficient to repel them. This produced great uneasiness among the soldiers of Narvaez, who had imagined there was nothing to do but to gather the spoils of a conquered country. Discontent and murmurings, however, were now of no avail; they were inclosed in an hostile city, and, without some extraordinary exertions, were inevitably undone. Cortes therefore made a desperate fall; but, after exerting his utmost efforts for a whole day, was obliged to retire with the loss of 12 killed, and upwards of 60 wounded. Another fall was attempted with the like bad success, and in it Cortes himself was wounded in the hand.

45  
But is fu-  
riously at-  
tacked by  
the na-  
tives.

The Spanish general was now thoroughly convinced of his error; and therefore betook himself to the only resource which was left; namely, to try what effect the interposition of Montezuma would have to soothe or overawe his subjects. When the Mexicans approached the next morning to renew the assault,

Mexico.

that unfortunate prince, at the mercy of the Spaniards, and reduced to the sad necessity of becoming the instrument of his own disgrace, and of the slavery of his people, advanced to the battlements in his royal robes, and with all the pomp in which he used to appear on solemn occasions. At the sight of their sovereign, whom they had been long accustomed to reverence almost as a god, the Mexicans instantly forebore their hostilities, and many prostrated themselves on the ground: but when he addressed them in favour of the Spaniards, and made use of all the arguments he could think of to mitigate their rage, they testified their resentment with loud murmurings; and at length broke forth with such fury, that before the soldiers, appointed to guard Montezuma, had time to cover him with their shields, he was wounded with two arrows, and a blow on his temple with a stone struck him to the ground. On seeing him fall, the Mexicans instantly fled with the utmost precipitation: but the unhappy monarch, now convinced that he was become an object of contempt even to his own subjects, oblatinately refused all nourishment; and thus in a short time ended his days.

43  
Montezuma  
killed.

44  
A terrible  
engagement  
between  
the Spaniards  
and  
Mexicans.

On the death of Montezuma, Cortes having lost all hope of bringing the Mexicans to any terms of peace, prepared for retreat. But his antagonists, having taken possession of a high tower in the great temple, which overlooked the Spanish quarters, and placing there a garrison of their principal warriors, the Spaniards were so much exposed to their missile weapons, that none could stir without danger of being killed or wounded. From this post, therefore, it was necessary to dislodge them at any rate; and Juan de Elicobar, with a large detachment of chosen soldiers, was ordered to make the attack. But Elicobar, though a valiant officer, and though he exerted his utmost efforts, was thrice repulsed. Cortes, however, sensible, that not only his reputation, but the safety of his army, depended on the success of this assault, caused a buckler to be tied to his arm, as he could not manage it with his wounded hand, and rushed with his drawn sword among the thickest of the combatants. Encouraged by the presence of their general, the Spaniards returned to the charge with such vigour, that they gradually forced their way up the steps, and drove the Mexicans to the platform at the top of the tower. There a dreadful carnage began; when two young Mexicans of high rank, observing Cortes, as he animated his soldiers, resolved to sacrifice their own lives in order to cut off the author of so many calamities which desolated their country. They approached him in a suppliant posture, as if they intended to lay down their arms, and seizing him in a moment, hurried him towards the battlements, over which they threw themselves headlong, in hopes of dragging him along with them. But Cortes, by his strength and agility, disengaged himself from their grasp; so that the two Mexicans perished alone.

As soon as the Spaniards became masters of the tower, they set fire to it, and without further molestation continued the preparations for their retreat. This became the more necessary, as their enemies, astonished at this last effort of their valour, had now entirely changed their system of hostility; and, instead of incessant attacks, endeavoured, by barricading the streets, and breaking down the causeways, to cut off

Mexico.

the communication of the Spaniards with the continent, and thus to starve an enemy whom they could not subdue. The first point to be determined was whether they should march out openly in the face of day, when they could discern every danger, or whether they should endeavour to retire fcreely in the night. The latter was preferred, partly from hopes that the superstition of the Mexicans would prevent them from attacking them in the night, and partly from their own superstition in giving credit to the predictions of a private soldier, who pretended to astrology, and assured them of success if they retreated in this manner. Towards midnight, therefore, they began their march, in three divisions. Sandoval led the van; Pedro Alvarado and Veles Guez de Lean had the conduct of the rear; and Cortes commanded in the centre, where he placed the prisoners, among whom were a son and two daughters of Montezuma, together with several Mexicans of distinction; the artillery, baggage, and a portable bridge of timber intended to be laid over the breaches in the causeway. They marched in profound silence along the causeway which led to Tacuba, because it was shorter than any of the rest, and, lying most remote from the road towards Tlafcala and the sea-coast, had been left most entire by the Mexicans.

They reached the first breach in the causeway without molestation, hoping that their retreat was undiscovered. But the Mexicans had not only watched all their motions, but made preparations for a most formidable attack. While the Spaniards were intent upon placing their bridges in the breach, and occupied in conducting their horses and artillery along it, they were suddenly alarmed with the sound of warlike instruments, and found themselves assaulted on all sides by an innumerable multitude of enemies. Unfortunately the wooden bridge was wedged so fast in the mud by the weight of the artillery, that it was impossible to remove it. Dimayed at this accident, the Spaniards advanced with precipitation to the second breach. The Mexicans hemmed them in on every side; and though they defended themselves with their usual courage, yet, crowded as they were in a narrow causeway, their discipline and military skill were of little avail; nor did the obscurity of the night allow them to derive much advantage from their fire-arms or the superiority of their other weapons. At last the Spaniards, overborne with the numbers of their enemies, began to give way, and in a moment the confusion was universal. Cortes, with about 100 foot-soldiers, and a few horse, forced his way over the two remaining breaches in the causeway, the bodies of the dead serving to fill up the chasms, and reached the main land. Having formed them as soon as they arrived, he returned with such as were yet capable of service, to assist his friends in their retreat. He met with part of his soldiers who had forced their way through the enemy, but found many more overwhelmed by the multitude of their aggressors, or perishing in the lake; and heard the grievous lamentations of others whom the Mexicans were carrying off in triumph, to be sacrificed to the god of war.

45  
Cortes re-  
treats with  
great loss.

In this fatal retreat more than one half of Cortes's army perished, together with many officers of distinction. All the artillery, ammunition, and baggage

were

Mexico

were lost; the greater part of the horses and above 2000 Tlascalans were killed, and only a very small part of their treasure saved. The first care of the Spanish general was to find some shelter for his wearied troops; for, as the Mexicans inflicted them on every side, and the people of Tacuba began to take arms, he could not continue in his present station. At last he discovered a temple seated on an eminence, in which he found not only the shelter he wanted, but some provisions; and though the enemy did not intermit their attacks throughout the day, they were without much difficulty prevented from making any impression. For six days after, they continued their march through a barren, ill-cultivated, and thinly-peopled country, where they were often obliged to feed on berries, roots, and the stalks of green maize; at the same time they were harassed without intermission by large parties of Mexicans, who attacked them on all sides. On the sixth day they reached Otumba, not far from the road between Mexico and Tlascala. Early next morning they began to advance towards it, flying parties of the enemy still hanging on their rear; and amidst the insults with which they accompanied their hostilities, Donna Marina remarked, that they often exclaimed with exultation, "Go on, robbers; go to the place where you shall quickly meet the vengeance due to your crimes." The meaning of this threat the Spaniards did not comprehend, until they reached the summit of an eminence before them. There a spacious valley opened to their view, covered with a vast army as far as the eye could reach. The Mexicans, while with one body of their troops they harassed the Spaniards in their retreat, had assembled their principal force on the other side of the lake; and marching along the road which led directly to Tlascala, posted it in the plain of Otumba, through which they knew Cortes must pass. At the sight of this incredible multitude, which they could survey at once from the rising ground, the Spaniards were astonished, and even the boldest began to despair. But Cortes, without allowing their fears time to operate, after warning them briefly that no alternative remained but to conquer or die, led them instantly to the charge. The Mexicans waited their approach with unusual fortitude; yet, such was the superiority of the Spanish discipline and arms, that the impression of this small body was irresistible; and which ever way its force was directed, it penetrated and dispersed the most numerous battalions. But while these gave way in one quarter, new combatants advanced from another; and the Spaniards, though successful in every attack, were ready to sink under these repeated efforts, without seeing any end to their toil, or any hope of victory. At that time Cortes observed the great standard of the empire, which was carried before the Mexican general, advancing; and fortunately recollecting to have heard, that on the fate of it depended the event of every battle, he assembled a few of his bravest officers, whose horses were still capable of service, and, placing himself at their head, pushed towards the standard with such impetuosity that he bore down every thing before him. A chosen body of nobles, who guarded the standard, made some resistance, but were soon broken. Cortes, with a stroke of his lance, wounded the Mexican general, and threw him to the ground. One of his fol-

lowers alighting, put an end to his life, and laid hold of the imperial standard. The moment that their leader fell, and the standard, towards which all directed their eyes, disappeared, an universal panic struck the Mexicans; and, as if the bond which held them together had been dissolved, every ensign was lowered, each soldier threw away his weapons, and fled with precipitation to the mountains. The Spaniards, unable to pursue them far, returned to collect the spoils of the field; and these were so valuable as to be some compensation for the wealth which they had lost in Mexico; for in the enemy's army were most of their principal warriors dressed out in their richest ornaments, as if they had been marching to assured victory.

The day after this important action, (being July 8th 1520), the Spaniards entered the Tlascalan territories, where they were received with the most cordial friendship. Cortes endeavoured to avail himself of this disposition as much as possible; for which purpose he distributed among them the rich spoils taken at Otumba with such a liberal hand, that he made himself sure of obtaining from the republic whatever he should desire. He drew a small supply of ammunition, and two or three field-pieces from his stores at Vera Cruz. He dispatched an officer of confidence with four ships of Narvaez's fleet to Hispaniola and Jamaica, to engage adventurers, and to purchase horses, gunpowder, and other military stores. And, as he knew that it would be in vain to attempt the reduction of Mexico, unless he could secure the command of the lake, he gave orders to prepare, in the mountains of Tlascala, materials for building 12 brigantines, so that they might be carried thither in pieces, ready to be put together, and launched when he stood in need of their service. But, in the mean time, his soldiers, alarmed at the thoughts of being exposed to such calamities a second time, presented a remonstrance to their general, in which they represented the imprudence of attacking a powerful empire with his shattered forces, and formally required him to return back to Cuba. All the eloquence of Cortes could now only prevail with them to delay their departure for some time, when he promised to dismiss such as should desire it. However, this was only a pretence; for Cortes, in fact, had the conquest of Mexico as much at heart as ever. Without giving his soldiers an opportunity of cabaling, therefore, he daily employed them against the people of the neighbouring provinces, who had cut off some detachments of Spaniards during his misfortunes at Mexico; and by which, as he was constantly attended with success, his men soon resumed their wonted sense of superiority.

But all the efforts of Cortes could have been of little avail, had he not unexpectedly obtained a reinforcement of Spanish soldiers. The governor of Cuba, to whom the success of Narvaez appeared an event of infallible certainty, having sent two small ships after him with new instructions, and a supply of men and military stores, the officer whom Cortes had appointed to command on the coast, artfully decoyed them into the harbour of Vera Cruz, seized the vessels, and easily persuaded the soldiers to follow the standard of a more able leader than him whom they were destined to join. Soon after, three ships of more considerable force came into the harbour separately. These belonged to an

Mexico.

47  
Mexicans  
defeated.46  
The battle  
of Otumba.48  
Cortes re-  
ceives an  
unexpected  
reinforce-  
ment.

Mexico.

an armament fitted out by Francisco de Garay, governor of Jamaica, who had long aimed at dividing with Cortes the glory and gain of annexing the empire of Mexico to the crown of Castile. They had, however, unadvisedly made their attempt on the northern provinces, where the country was poor, and the inhabitants fierce and warlike; so that, after a succession of disasters, they were now obliged to venture into Vera Cruz, and cast themselves upon the mercy of their countrymen; and here they also were soon persuaded to throw off their allegiance to their master, and to enlist with Cortes. About the same time a ship arrived from Spain, freighted by some private adventurers, with military stores; and the cargo was eagerly purchased by Cortes, while the crew, following the example of the rest, joined him at Tlascala.

49  
He sets out  
again for  
Mexico.

From these various quarters, the army of Cortes was augmented with 180 men, and 20 horses; by which means he was enabled to dismiss such of the soldiers of Narvaez as were most troublesome and discontented; after the departure of whom, he still mustered 550 infantry, of whom 80 were armed with muskets or cross-bows, 40 horsemen, and nine pieces of artillery. At the head of these, with 10,000 Tlascalans and other friendly Indians, he began his march towards Mexico, on the 28th of December, six months after his fatal retreat from that city.

50  
Preparations of the  
Mexicans  
for their  
defence.

The Mexicans, in the mean time, had made the best preparations they could for opposing such a formidable enemy. On the death of Montezuma, his brother Quetzlavaca was raised to the throne; and he had an immediate opportunity of shewing that he was worthy of their choice, by conducting in person those fierce attacks which obliged the Spaniards to retire from his capital. His prudence in guarding against the return of the invaders was equal to the spirit he had shewn in driving them out. He repaired what the Spaniards had ruined in the city, strengthened it with such fortifications as his people could erect; and besides filling his magazines with the usual weapons of war, gave directions to make long spears, headed with the swords and daggers which they had taken from the Spaniards, in order to annoy the cavalry. But in the midst of these preparations he was taken off by the small-pox; and Guatimozin, his nephew and son-in-law, raised to the throne.

As soon as Cortes entered the enemy's territories, he discovered various preparations to obstruct his progress. But his troops forced their way with little difficulty; and took possession of Tezcuco, the second city of the empire, situated on the banks of the lake, about 20 miles from Mexico. Here he determined to establish his head-quarters, as the most proper station for launching his brigantines, as well as for making his approaches to the capital. In order to render his residence there more secure, he deposed the cazique or chief, who was at the head of that community, under pretence of some defect in his title, and substituted in his place a person whom a faction of the nobles pointed out as the right heir of that dignity. Attached to him by this benefit, the new cazique and his adherents served the Spaniards with inviolable fidelity.

As the construction of the brigantines advanced slowly under the unskillful hands of soldiers and Indians, whom Cortes was obliged to employ in assisting

three or four carpenters who happened fortunately to be in his service, and as he had not yet received the reinforcement which he expected from Hispaniola, he was not in a condition to turn his arms directly against the capital. To have attacked a city so populous, so well prepared for defence, and in a situation of such peculiar strength, must have exposed his troops to inevitable destruction. Three months elapsed before the materials for constructing the brigantines were finished, and before he heard any thing with respect to the success of his negotiation in Hispaniola. This, however, was not a season of inaction to Cortes. He attacked successively several of the towns situated around the lake; and though all the Mexican power was exerted to obstruct his operations, he either compelled them to submit to the Spanish crown, or reduced them to ruins. Other towns he endeavoured to conciliate by more gentle means; and though he could not hold any intercourse with the inhabitants but by the intervention of interpreters, yet, under all the disadvantage of that tedious and imperfect mode of communication, he had acquired such thorough knowledge of the state of the country, as well as of the dispositions of the people, that he conducted his negotiations and intrigues with astonishing dexterity and success. Most of the cities adjacent to Mexico were originally the capitals of small independent states; and some of them having been but lately annexed to the Mexican empire, still retained the remembrance of their ancient liberty, and bore with impatience the rigorous yoke of their new masters. Cortes having early observed symptoms of their disaffection, availed himself of this knowledge to gain their confidence and friendship. By offering with confidence to deliver them from the odious dominion of the Mexicans, and by liberal promises of more indulgent treatment if they would unite with him against their oppressors, he prevailed on the people of several considerable districts, not only to acknowledge the king of Castile as their sovereign, but to supply the Spanish camp with provisions, and to strengthen his army with auxiliary troops. Guatimozin, on the first appearance of defection among his subjects, exerted himself with vigour to prevent or to punish their revolt; but, in spite of his efforts, the spirit continued to spread. The Spaniards gradually acquired new allies; and with deep concern he beheld Cortes arming against his empire those very hands which ought to have been active in his defence, and ready to advance against the capital at the head of a numerous body of his own subjects.

While, by these various methods, Cortes was gradually circumscribing the Mexican power within such narrow limits that his prospect of overturning it seemed neither to be uncertain nor remote, all his schemes were well nigh defeated by a conspiracy against his own person, and which was discovered only a short time before it was to have been executed. Though many were concerned, Cortes did not think proper to punish any more than the principal ringleader, whom he caused immediately to be hanged; and then, without allowing them leisure to ruminate on what had happened, and as the most effectual means of preventing the return of a mutinous spirit, he determined to call forth his troops immediately to action. Fortunately, a proper occasion for this occurred, without his seeming

Mexico.

55  
Cortes  
makes  
great pro-  
gress.



Mexico. to court it. He received intelligence, that the materials for building the brigantines were at length completely finished, and waited only for a body of Spaniards to conduct them to Tezeuco. The command of this convoy, consisting of 200 foot-soldiers, 15 horsemen, and 2 field-pieces, he gave to Sandoval, who, by the vigilance, activity, and courage, which he manifested on every occasion, was growing daily in his confidence, and in the estimation of his fellow-soldiers. The service was no less singular than important; the beams, the planks, the masts, the cordage, the sails, the iron-work, and all the infinite variety of articles requisite for the construction of 13 brigantines, were to be carried 60 miles over land, thro' a mountainous country, by people who were unacquainted with the ministry of domestic animals, or the aid of machines to facilitate any work of labour. The Tlascalans furnished 8000 *Tamenes*, an inferior order of men destined for servile tasks, to carry the materials on their shoulders, and appointed 15,000 warriors to accompany and defend them. Sandoval made the disposition for their progress with great propriety, placing the *Tamenes* in the centre, one body of warriors in the front, another in the rear, with considerable parties to cover the flanks. To each of these he joined some Spaniards, not only to assist them in danger, but to accustom them to regularity and subordination. Parties of Mexicans frequently appeared hovering around them on the high grounds: but perceiving no prospect of success in attacking an enemy continually on his guard, and prepared to receive them, they did not venture to molest him; and Sandoval had the glory of conducting safely to Tezeuco, a convoy on which all the future operations of his countrymen depended.

<sup>52</sup> The Spaniards receive another reinforcement. This was followed by another event of no less moment. Four ships arrived at Vera Cruz from Hispaniola, with 200 soldiers, 80 horses, two battering cannon, and a considerable supply of ammunition and arms. Elevated with observing that all his preparatory schemes, either for recruiting his own army, or impairing the force of the enemy, had now produced their full effect, Cortes, impatient to begin the siege in form, hastened the launching of the brigantines. To facilitate this, he had employed a vast number of Indians, for two months, in deepening the small rivulet which runs by Tezeuco into the lake, and in forming it into a canal near two miles in length: and though the Mexicans, aware of his intentions, as well as of the danger which threatened them, endeavoured frequently to interrupt the labourers, or to burn the brigantines, the work was at last completed. On the 28th of April, all the Spanish troops, together with auxiliary Indians, were drawn up on the banks of the canal; and with extraordinary military pomp, heightened and rendered more solemn by the celebration of the most sacred rites of religion, the brigantines were launched. As they fell down the canal in order, Father Olmedo blessed them, and gave each its name. Every eye followed them with wonder and hope, until they entered the lake, when they hoisted their sails, and bore away before the wind. A general shout of joy was raised; all admiring that bold inventive genius, which, by means so extraordinary, that their success almost exceeded belief, had acquired the command of

a fleet, without the aid of which Mexico would have continued to sit the Spanish power and arms at defiance. Mexico.

<sup>53</sup> The city besieged. Cortes determined to attack the city from three different quarters; from Tezeuco on the east side of the lake, from Tacuba on the west, and from Cuycan towards the south. Those towns were situated on the principal causeways which led to the capital, and intended for their defence. He appointed Sandoval to command in the first, Pedro de Alvarado in the second, and Christoval de Olid in the third; allotting to each a numerous body of Indian auxiliaries, together with an equal division of Spaniards, who, by the junction of the troops from Hispaniola, amounted now to 86 horsemen, and 818 foot-soldiers; of whom 118 were armed with muskets or cross-bows. Their train of artillery consisted of three battering cannon, and 15 field-pieces. He reserved for himself, as the station of greatest importance and danger, the conduct of the brigantines, each armed with one of his small cannon, and manned with 25 Spaniards.

As Alvarado and Olid proceeded towards the posts assigned them, they broke down the aqueducts which the ingenuity of the Mexicans had erected for conveying water into the capital, and, by the distress to which this reduced the inhabitants, gave a beginning to the calamities which they were destined to suffer. Alvarado and Olid found the towns, of which they were ordered to take possession, deserted by their inhabitants, who had fled for safety to the capital, where Guatimozin had collected the chief force of his empire, as there alone he could hope to make a successful stand against the formidable enemies who were approaching to assault him.

<sup>54</sup> The Spaniards defeat the Mexicans, and become masters of the lake. The first effort of the Mexicans was to destroy the fleet of brigantines, the fatal effects of whose operations they foresaw and dreaded. Though the brigantines, after all the labour and merit of Cortes in forming them, were of inconsiderable bulk, rudely constructed, and manned chiefly with landmen, hardly possessed of skill enough to conduct them, they must have been objects of terror to a people unacquainted with any navigation but that of their lake, and possessed of no vessel larger than a canoe. Necessity, however, urged Guatimozin to hazard the attack; and hoping to supply by numbers what he wanted in force, he assembled such a multitude of canoes as covered the face of the lake. They rowed on boldly to the charge, while the brigantines, retarded by a dead calm, could scarcely advance to meet them. But as the enemy drew near, a breeze suddenly sprung up; in a moment the sails were spread, and the brigantines with irresistible impetuosity broke their feeble opponents, overtook many canoes, and dissipated the whole armament with such slaughter, as convinced the Mexicans, that the progress of the Europeans in knowledge and arts rendered their superiority greater on this new element than they had hitherto found it by land.

From that time Cortes remained master of the lake; and the brigantines not only preserved a communication between the Spaniards in their different stations, though at considerable distance from each other; but were employed to cover the causeways on each side, and keep off the canoes, when they attempted to annoy the troops as they advanced towards the city. He formed.

Mexico.

formed the brigantines in three divisions, allotting one to each station, with orders to second the operations of the officer who commanded there. From all the three stations he pushed on the attack against the city with equal vigour; but in a manner so very different from that whereby sieges are conducted in regular war, as might appear no less improper than singular to persons unacquainted with his situation. Each morning his troops assaulted the barricades which the enemy had erected on the causeways, forced their way over the trenches which they had dug, and thro' the canals where the bridges were broken down, and endeavoured to penetrate into the heart of the city, in hopes of obtaining some decisive advantage, which might force the enemy to surrender, and terminate the war at once; but when the obstinate valour of the Mexicans rendered the efforts of the day ineffectual, the Spaniards retired in the evening to their former quarters. Thus their toil and danger were, in some measure, continually renewed; the Mexicans repairing in the night what the Spaniards had destroyed through the day, and recovering the posts from which they had driven them. But necessity prescribed this slow and untoward mode of operation. The number of his troops was so small, that Cortes durst not, with a handful of men, attempt to make a lodgment in a city where he might be surrounded and annoyed by such a multitude of enemies. The remembrance of what he had already suffered by the ill-judged confidence with which he had ventured into such a dangerous situation, was still fresh in his mind. The Spaniards, exhausted with fatigue, were unable to guard the various posts which they daily gained; and though their camp was filled with Indian auxiliaries, they durst not devolve this charge upon them, because they were so little accustomed to discipline, that no confidence could be placed in their vigilance. Besides this, Cortes was extremely solicitous to preserve the city as much as possible from being destroyed, both as he destined it to be the capital of his conquests, and wished that it might remain as a monument of his glory. From all these considerations, he adhered obstinately, for a month after the siege was opened, to the system which he had adopted. The Mexicans, in their own defence, displayed valour which was hardly inferior to that with which the Spaniards attacked them. On land, on water, by night and by day, one furious conflict succeeded to another. Several Spaniards were killed, more wounded, and all were ready to sink under the toils of unintermitting service, which were rendered more intolerable by the injuries of the season, the periodical rains being now set in with their usual violence.

Astonished and disconcerted with the length and difficulties of the siege, Cortes determined to make one great effort to get possession of the city before he relinquished the plan which he had hitherto followed, and had recourse to any other mode of attack. With this view, he sent instructions to Alvarado and Sandoval to advance with their divisions to a general assault, and took the command in person of that posted on the causeway of Cuyocan. Animated by his presence, and the expectation of some decisive event, the Spaniards pushed forward with irresistible impetuosity. They broke through one barricade after another, forced their

Mexico.

way over the ditches and canals, and having entered the city, gained ground incessantly, in spite of the multitude and ferocity of their opponents. Cortes, though delighted with the rapidity of his progress, did not forget that he might still find it necessary to retreat; and in order to secure it, appointed Julian de Alderete, a captain of chief note in the troops which he had received from Hispaniola, to fill up the canals and gaps in the causeway as the main body advanced. That officer deeming it inglorious to be thus employed, while his companions were in the heat of action and the career of victory, neglected the important charge committed to him, and hurried on inconsiderately to mingle with the combatants. The Mexicans, whose military attention and skill were daily improving, no sooner observed this, than they carried an account of it to their monarch.

Guatimozin instantly discerned the consequences of the error which the Spaniards had committed, and, with admirable presence of mind, prepared to take advantage of it. He commanded the troops posted in the front to slacken their efforts, in order to allure the Spaniards to push forward, while he dispatched a large body of chosen warriors through different streets, some by land, and others by water, towards the great breach in the causeway, which had been left open. On a signal which he gave, the priests in the great temple struck the great drum consecrated to the god of war. No sooner did the Mexicans hear its doleful solemn sound, calculated to inspire them with contempt of death and with enthusiastic ardour, than they rushed upon the enemy with frantic rage. The Spaniards, unable to resist men urged on no less by religious fury than hope of success, began to retire, at first leisurely, and with a good countenance; but as the enemy pressed on, and their own impatience to escape increased, the terror and confusion became so general, that when they arrived at the gap in the causeway, Spaniards and Tlascalans, horsemen and infantry, plunged in promiscuously, while the Mexicans rushed upon them fiercely from every side, their light canoes carrying them through shoals which the brigantines could not approach. In vain did Cortes attempt to stop and rally his flying troops; fear rendered them regardless of his intreaties or commands.

55  
Cortes re-  
pulsed in  
attack.

Finding all his endeavours to renew the combat fruitless, his next care was to save some of those who had thrown themselves into the water; but while thus employed, with more attention to their situation than to his own, six Mexican captains suddenly laid hold of him, and were hurrying him off in triumph; and tho' two of his officers rescued him at the expence of their own lives, he received several dangerous wounds before he could break loose. Above 60 Spaniards perished in the rout; and what rendered the disaster more afflicting, 40 of these fell alive into the hands of an enemy never known to shew mercy to a captive.

The approach of night, though it delivered the defeated Spaniards from the attacks of the enemy, ushered in, what was hardly less grievous, the noise of their barbarous triumph, and of the horrid festival with which they celebrated their victory. Every quarter of the city was illuminated; the great temple shone with such peculiar splendour, that the Spaniards could plainly

Mexico. plainly see the people in motion, and the priests busy in hastening the preparations for the death of the prisoners. Through the gloom they fancied that they discerned their companions by the whiteness of their skins, as they were stripped naked and compelled to dance before the image of the god to whom they were to be offered. They heard the shrieks of those who were sacrificed, and thought they could distinguish each unhappy victim by the well-known sound of his voice. Imagination added to what they really saw or heard, and augmented its horror. The most unfeeling melted into tears of compassion, and the stoutest heart trembled at the dreadful spectacle which they beheld.

Cortes, who, besides all that he felt in common with his soldiers, was oppressed with the additional load of anxious reflections natural to a general on such an unexpected calamity, could not like them relieve his mind by giving vent to its anguish. He was obliged to assume an air of tranquillity in order to revive the spirits and hopes of his followers. The juncture, indeed, required an extraordinary exertion of fortitude. The Mexicans, elated with their victory, sallied out next morning to attack him in his quarters. But they did not rely on the efforts of their own arms alone. They sent the heads of the Spaniards whom they had sacrificed to the leading men in the adjacent provinces, and assured them that the god of war, appeased by the blood of their invaders, which had been shed so plentifully on his altars, had declared with an audible voice, that in eight days time those hated enemies should be finally destroyed, and peace and prosperity re-established in the empire.

A prediction, uttered with such confidence, and in terms so void of ambiguity, gained universal credit among a people prone to superstition. The zeal of the provinces which had already declared against the Spaniards augmented, and several which had hitherto remained inactive took arms with enthusiastic ardour to execute the decrees of the gods. The Indian auxiliaries who had joined Cortes, accustomed to venerate the same deities with the Mexicans, and to receive the responses of their priests with the same implicit faith, abandoned the Spaniards as a race of men devoted to certain destruction. Even the fidelity of the Tlascalans was shaken, and the Spanish troops were left almost alone in their stations. Cortes finding that he attempted in vain to dispel the superstitious fears of his confederates by argument, took advantage from the imprudence of those who had framed the prophecy in fixing its accomplishment so near at hand, to give them a striking demonstration of his falsity. He suspended all military operations during the period marked out by the oracle. Under cover of the brigantines, which kept the army at a distance, his troops lay in safety, and the fatal term expired without any disaster.

His allies, ashamed of their own credulity, returned to their station. Other tribes, judging that the gods, who had now deceived the Mexicans, had decreed finally to withdraw their protection from them, joined his standard; and such was the levity of a simple people, moved by every slight impression, that, in a short time after such a general detection of his confederates, Cortes saw himself, if we may believe his own account, at the head of 150,000 Indians. Even with such a numerous army, he found it necessary to adopt

a new and more wary system of operation. Instead of renewing his attempts to become master of the city at once, by such bold but dangerous efforts of valour as he had already tried, he made his advances gradually, and with every possible precaution against exposing his men to any calamity similar to that which they still bewailed. As the Spaniards pushed forward, the Indians regularly repaired the causeways behind them. As soon as they got possession of any part of the town, the houses were instantly levelled with the ground. Day by day, the Mexicans, forced to retire as their enemies gained ground, were hemmed in within more narrow limits. Guatimozin, though unable to stop the career of the enemy, continued to defend his capital with obstinate resolution, and disputed every inch of ground. But the Spaniards, having not only varied their mode of attack, but, by orders of Cortes, having changed the weapons with which they fought, were again armed with the long Chinantlan spears, which they had employed with such success against Narvaez; and, by the firm array in which this enabled them to range themselves, they repelled, with little danger, the loose assault of the Mexicans: incredible numbers of them fell in the conflicts, which they renewed every day. While war waited without, famine began to consume them within the city. The Spanish brigantines, having the entire command of the lake, rendered it impossible to receive any supply of provisions by water. The vast number of his Indian auxiliaries enabled Cortes to shut up the avenues to the city by land. The stores which Guatimozin had laid up were exhausted by the multitudes which crowded into the capital, to defend their sovereign and the temples of their gods. Not only the people, but persons of the highest rank, felt the utmost distress of want. What they suffered brought on infectious and mortal distempers, the last calamity that visits besieged cities, and which filled up the measure of their woes.

But, under the pressure of so many and such various evils, the spirit of Guatimozin remained firm and unsubdued. He rejected with scorn every overture of peace from Cortes; and, disdaining the idea of submitting to the oppressors of his country, determined not to survive its ruin. The Spaniards continued their progress. At length all the three divisions penetrated into the great square in the centre of the city, and made a secure lodgment there. Three-fourths of the city were now reduced, and laid in ruins. The remaining quarter was so closely pressed, that it could not long withstand assailants who attacked it from their new station with superior advantage, and more assured expectation of success. The Mexican nobles, solicitous to save the life of a monarch whom they revered, prevailed on Guatimozin to retire from a place where resistance was now vain, that he might rouse the more distant provinces of the empire to arms, and maintain there a more successful struggle with the public enemy. In order to facilitate the execution of this measure, they endeavoured to amuse Cortes with overtures of submission, that, while his attention was employed in adjusting the articles of pacification, Guatimozin might escape unperceived. But they made this attempt upon a leader of greater sagacity and discernment than to be deceived by their arts. Cortes suspec-

Mexico.

56  
The Mexi-  
cans renew  
the attack  
with great  
fury.

58  
Guatimozin  
refuses to  
submit on  
any terms.

57  
Cortes ad-  
opts a more  
cautious  
method of  
proceeding.

Mexico.

ting their intention, and aware of what moment it was to defeat it, appointed Sandoval, the officer on whose vigilance he could most perfectly rely, to take the command of the brigantines, with strict injunctions to watch every motion of the enemy. Sandoval, attentive to the charge, observing some large canoes crowded with people rowing along the lake with extraordinary rapidity, instantly gave the signal to chase. Gracia Holguin, who commanded the fleetest brigantine, soon overtook them, and was preparing to fire on the foremost canoe, which seemed to carry some person whom all the rest followed and obeyed. At once the rowers dropt their oars, and all on board, throwing down their arms, conjured him with cries and tears to forbear, as the emperor was there. Holguin eagerly seized his prize; and Guatimozin, with a dignified composure, gave himself up into his hands, requesting only that no insult might be offered to the empress or his children. When conducted to Cortes, he appeared neither with theullen fierceness of a barbarian, nor with the dejection of a supplicant. "I have done," said he, addressing himself to the Spanish general, "what became a monarch. I have defended my people to the last extremity. Nothing now remains but to die. Take this dagger," laying his hand on one which Cortes wore, "plant it in my breast, and put an end to a life which can no longer be of use."

59  
He is taken  
prisoner.

60  
Mexico  
submits.

As soon as the fate of their sovereign was known, the resistance of the Mexicans ceased; and Cortes took possession of that small part of the capital which yet remained undestroyed. Thus terminated the siege of Mexico, the most memorable event in the conquest of America. It continued 75 days, hardly one of which passed without some extraordinary effort of one party in the attack, or of the other in the defence of a city, on the fate of which both knew that the fortune of the empire depended. As the struggle here was more obstinate, it was likewise more equal, than any between the inhabitants of the Old and New Worlds. The great abilities of Guatimozin, the number of his troops, the peculiar situation of his capital, so far counterbalanced the superiority of the Spaniards in arms and discipline, that they must have relinquished the enterprize, if they had trusted for success to themselves alone. But Mexico was overturned by the jealousy of neighbours who dreaded its power, and by the revolt of subjects impatient to shake off its yoke. By their effectual aid, Cortes was enabled to accomplish what, without such support, he would hardly have ventured to attempt. How much sorer this account of the reduction of Mexico may detract, on the one hand, from the marvellous relations of some Spanish writers, by ascribing that to simple and obvious causes which they attribute to the romantic valour of their countrymen, it adds, on the other, to the merit and abilities of Cortes, who, under every disadvantage, acquired such an ascendancy over unknown nations, as to render them instruments towards carrying his scheme into execution.

The exultation of the Spaniards, on accomplishing this arduous enterprize, was at first excessive. But this was quickly damped by the cruel disappointments of

those sanguine hopes which had animated them amidst so many hardships and dangers. Instead of the inexhaustible wealth which they expected from becoming masters of Montezuma's treasures, and the ornaments of so many temples, their rapaciousness could collect only an inconsiderable booty amidst ruins and desolation (A). Guatimozin, aware of his impending fate, had ordered what remained of the riches amassed by his ancestors to be thrown into the lake. The Indian auxiliaries, while the Spaniards were engaged in conflict with the enemy, had carried off the most valuable part of the spoil. The sum to be divided among the conquerors was so small, that many of them declined to accept of the pittance which fell to their share, and all murmured and exclaimed; some against Cortes and his confidants, whom they suspected of having secretly appropriated to their own use a large portion of the riches which should have been brought into the common stock; others against Guatimozin, whom they accused of obitancy, in refusing to discover the place where he had hidden his treasure.

Arguments, intreaties, and promises, were employed in order to soothe them; but with so little effect, that Cortes, from solicitude to check this growing spirit of discontent, gave way to a deed which stained the glory of all his great actions. Without regarding the former dignity of Guatimozin, or feeling any reverence for those virtues which he had displayed, he subjected the unhappy monarch, together with his chief favourite, to torture, in order to force from them a discovery of the royal treasures, which it was supposed they had concealed. Guatimozin bore whatever the refined cruelty of his tormentors could inflict, with the invincible fortitude of an American warrior. His fellow-sufferer, overcome by the violence of the anguish, turned a dejected eye towards his master, which seemed to implore his permission to reveal all that he knew. But the high-spirited prince, darting on him a look of authority mingled with scorn, checked his weakness, by asking, "Am I now reposing on a bed of flowers?" Overawed by the reproach, he persevered in his dutiful silence, and expired. Cortes, ashamed of a scene so horrid, rescued the royal victim from the hands of his torturers, and prolonged a life reserved for new indignities and sufferings.

The fate of the capital, as both parties had fore-  
seen, decided that of the empire. The provinces sub-  
mitted one after another to the conquerors. Small  
detachments of Spaniards marching through them  
without interruption, penetrated, in different quarters,  
to the great Southern Ocean, which, according to the  
ideas of Columbus, they imagined would open a short  
as well as easy passage to the East Indies, and secure  
to the crown of Castile all the envied wealth of those  
fertile regions; and the active mind of Cortes began  
already to form schemes for attempting this important  
discovery. In his after schemes, however, he was dis-  
appointed; but Mexico hath ever since remained in the  
hands of the Spaniards.

Mexico is almost entirely situated within the torrid  
zone. The air is excessively warm, moist, and un-  
wholesome, on the coasts of the North Sea. These  
Climate,  
soil &c. of  
Mexico.

(A) The gold and silver, according to Cortes, amounted only to 120,000 pesos, Relat. 280, A. a sum far inferior to that which the Spaniards had formerly divided in Mexico.

Mexico.

61  
Guatimozin  
tortured.

62  
The Span-  
iards become  
masters of  
the whole  
Mexican  
empire.

63  
Climate,  
soil &c. of  
Mexico.

defects of the climate are infinitely less felt on the coasts of the South Sea, and hardly at all in the inland country, which is intersected by a chain of mountains, that are supposed to be a continuation of the Cordelera.

The quality of the soil has the same variations. The eastern part is low, marshy, overflowed in the rainy seasons, covered with impenetrable forests, and totally uncultivated. The soil on the western side is higher, of a better quality, on which there are many fields, and several houses are built upon it. In the low lands there are districts on which nature has been very liberal; but, like every country situated under the tropics, they abound more in fruits than in corn.

The population of this vast empire is not less various than its soil. Its most distinguished inhabitants are the Spaniards sent hither by the court, to fill the posts of government. They are obliged, like those in the mother-country who aspire to any ecclesiastical, civil, or military employments, to prove that there have been neither heretics, Jews, Mohammedans, nor any persons in their family who have been called before the inquisition for four generations. Merchants who are desirous of going to Mexico, as well as to other parts of America, without becoming colonists, are compelled to observe the same forms. They are also obliged to swear that they have 300 palms of merchandise, their own property, in the fleet in which they embark, and that they will not carry their wives with them. On these absurd conditions they become the principal agents of the European commerce with the Indies. Though their charter is only to continue three years, and a little longer for countries more remote, it is of great importance. To them alone belongs the right of selling, as commissioners, the major part of the cargo. If these laws were observed, the merchants stationed in the new world would be confined to dispose of what they have received on their own account.

The predilection which administration has for Spaniards born in Europe, has reduced the Spanish Creoles to acquiesce in subordinate stations. The descendants of the companions of Cortes, and of those who came after them, being constantly excluded from all places of honour or of trust that were any way considerable, have seen the gradual decay of the power that supported their fathers. The habit of being obliged to bear that unjust contempt with which they have been treated, has at last made them become really contemptible. They have totally lost, in the vices which originate from indolence, from the heat of the climate, and from a superfluous enjoyment of all things, that firmness and that sort of pride which have ever characterized their nation. A barbarous luxury, shameful pleasures, and romantic intrigues, have enervated all the vigour of their minds, and superstition hath completed the ruin of their virtues. Blindly devoted to priests too ignorant to enlighten them by their instructions, too depraved to edify them by their example, and too mercenary to attend to both these duties of their function, they have no attachment to any part of their religion but that which enfeebls the mind, and have neglected what might have contributed to rectify their morals.

The Mestees, who constitute the third order of citizens, are held in still greater contempt. It is well known that the court of Madrid, in order to replenish a part of that dreadful vacancy which the avarice and cruelty of the conquerors had occasioned, and to regain the confidence of those who had escaped their fury, encouraged as much as possible the marriage of Spaniards with Indian women. These alliances, which became pretty common throughout all America, were particularly frequent in Mexico, where the women had more understanding and were more agreeable than in other places. The Creoles transferred to this mixed progeny the contemptuous slight they received from the Europeans. Their condition, equivocal at first, in process of time at last was fixed between the whites and the blacks.

These blacks are not very numerous in Mexico. As the natives are more intelligent, more robust, and more industrious, than those of the other colonies, they have hardly introduced any Africans except such as were required either to indulge the caprice, or perform the domestic service, of rich people. These slaves, who are much beloved by their masters, on whom they absolutely depend, who purchased them at an extravagant price, and who make them the ministers of their pleasures, take advantage of the high favour they enjoy, to oppress the Mexicans. They assume over these men, who are called *free*, an ascendancy which keeps up an implacable hatred between the two nations. The law has studied to encourage this aversion, by taking effectual measures to prevent all connection between them. Negroes are prohibited from having any amorous correspondence with the Indians; the men, on pain of being mutilated, the women of being severely punished. On all these accounts, the Africans, who in other settlements are enemies to Europeans, are in the Spanish Indies their warm friends.

Authority has no need of this support, at least in Mexico, where population is no longer what it was formerly. The first historians, and those who copied them, have recorded, that the Spaniards found there 10,000,000 of souls. This is supposed to have been the exaggerated account of conquerors, to exalt the magnificence of their triumph; and it was adopted, without examination, with so much the more readiness, as it rendered them the more odious. We need only trace with attention the progress of those ruffians who at first desolated these fine countries, in order to be convinced that they had not succeeded in multiplying men at Mexico and the adjacent parts, but by depopulating the centre of the empire; and that the provinces which are remote from the capital, differed in nothing from the other deserts of South and North-America. It is making a great concession, to allow that the population of Mexico has only been exaggerated one-half: for it does not now much exceed 2,000,000.

It is generally believed, that the first conquerors <sup>64</sup> massacred the Indians out of wantonness, and that <sup>treated by</sup> even the priests incited them to these acts of ferocity, <sup>the Spaniards.</sup> Undoubtedly these inhuman soldiers frequently shed blood without even an apparent motive; and certainly their fanatic missionaries did not oppose these barbarities as they ought to have done. This was not,

Mexico.

degree. The Spaniards are encouraged to prosecute the labours which these cultures require, from the happy circumstance of their having discovered iron mines, which were entirely unknown to the Mexicans, as well as some mines of a kind of copper that is hard enough to serve for implements of husbandry. All these articles, however, for want of men and industry, are merely consumed within the country.— There is only the vanilla, indigo, and cochineal, which make part of the trade of Mexico with other nations.

*New-Mexico*, so called because of its being discovered later than Old-Mexico, a country of America, is bounded on the north by high mountains, beyond which is a country altogether unknown; by Louisiana on the east; by New-Spain on the south; and on the west by the gulph of California, and the Rio Colorado; extending, it is said, above 100 miles from east to west, and about 900 from south to north; but the twentieth part of the country within these limits is neither cultivated nor inhabited either by Spaniards or Indians. As it lies in the midst of the temperate zone, the climate, in general, is very pleasant; the summers, though very warm, are neither sultry nor unwholesome; and the winters, though pretty sharp, are far from being insupportable, and, for the most part, clear and healthy.

The greatest encomiums are lavished on the fertility of the soil, the richness of the mines, and the variety of valuable commodities produced in this country. It is said to be beautifully diversified with fields, meadows, rising grounds, and rivers; abounding with fruit and timber-trees, turquoises, emeralds, and other precious stones, mines of gold and silver, a great variety of wild and tame cattle, fish, and fowls. Upon the whole, we may safely affirm, that New-Mexico is among the pleasantest, richest, and most plentiful countries in America, or any other part of the world. There are few great or navigable rivers in it: the most considerable are, the Rio Solado and Rio del Norte, which, with several smaller streams, fall into the gulph of Mexico. On the coast of the gulph are divers bays, ports, and creeks, which might be easily converted into excellent harbours if the Spaniards were possessed of any portion of that commercial spirit which animates the other maritime nations of Europe.

The Spanish writers tell us, that New-Mexico is inhabited by a great variety of Indian nations or tribes, totally unconnected with each other: but the principal are the Apaches, a brave, warlike, resolute people; fond of liberty, and the inveterate enemies of tyranny and oppression. About the close of the last century, thinking themselves aggrieved by the Spanish government, they made a general insurrection, and did a great deal of mischief; but were at last obliged to submit, and have since been curbed by stronger garrisons. Most of the natives are now Christians. When the Spaniards first entered this country, they found the natives well clothed, their lands cultivated, their villages neat, and their houses built with stone. Their flocks also were numerous, and they lived more comfortably than most of the other savages of America. As to religion, they were idolaters, and worshipped the sun and moon; but whether they offered human sacrifices, we are not sufficiently informed.

Mezeray.

As to the number of the provinces of this country, we can advance nothing certain; some writers making them only five, others 15, 18, 20, and 25; but adding no description, either of them or the towns contained in them, excepting the capital, Santa Fé, which we are told, stands near the source of the Rio del Norte, in 36° of north latitude, and about 130 leagues from the gulph: that it is a well-built handsome, rich town; and the seat of a bishop, suffragan of Mexico, as well as of the governor of the province, who is subordinate to the viceroy of Mexico, or New-Spain.

MEZERAY (Francis Eudes de), an eminent French historian, the son of Isaac Eudes a surgeon, was born at Rye, in Lower Normandy, in 1610; and took the surname of *Mezeray*, from a hamlet near Rye. Having performed his studies at Caen, he discovered a strong inclination to poetry; but going to Paris, he, by the advice of one of his friends, applied himself to the study of politics and history, and procured the place of commissary at war, which he held for two campaigns. He then shut himself up in the college of St Barbe, in the midst of books and manuscripts; and, in 1643, published the first volume of the History of France, in folio; and some years after, the other two volumes. Mezeray in that work surpassed all who had written the history of France before him, and was rewarded by the king with a pension of 4000 livres. In 1668, he published an Abridgment of his History of France, in three volumes 4to. which was well received by the public: but as he inserted in that work the origin of most of the taxes, with very free reflections, Mr Colbert complained of it, when Mezeray promised to correct what he had done in a second edition; but those corrections being only palliations, the minister caused half of his pension to be suppressed. Mezeray complained of this in very severe terms; when he obtained no other answer than the suppression of the other half. Vexed at this treatment, he resolved to write on subjects that could not expose him to such disappointments; and composed his treatise on the origin of the French, which did him much honour. He was elected perpetual secretary to the French academy; and died in 1683. He is said to have been a man extremely negligent in his person; and so careless in his dress, that he might have passed for a beggar, rather than for what he was. He was actually seized one morning by the *archers des pauvres*, or parish-officers; which mistake was so far from provoking him, that he was highly diverted with it, and told them, that "he was not able to walk on foot, but that as soon as a new wheel was put to his chariot, he would attend them wherever they thought proper." He used to study and write by candle-light, even at noon-day in summer; and, as if there had been no sun in the world, always waited upon his company to the door with a candle in his hand. With regard to religion, he affected Pyrrhonism; which however was not, it seems, so much in his heart as in his mouth. This appeared from his last sickness: for having sent for those friends who had been the most usual witnesses of his licentious talk about religion, he made a sort of recantation, which he concluded with desiring them "to forget what he might formerly have said upon the subject of religion, and to remember, that Mezeray dying was

**Meziers** a better believer than Mezeray in health." Besides his history, he also wrote, 1. A continuation of the history of the Turks. 2. A French translation of John de Sarisbury's Latin treatise on the vanities of the court. 3. There are attributed to him several satires against the government; and in particular, those that bear the name of *Sandricourt*.

**MEZIERS**, a strong town of France, in Champagne, with a citadel. It was besieged with a powerful army by Charles V. who was obliged to raise the siege in 1521. It is seated on the river Meuse, partly upon a hill, and partly in a valley, in E. Long. 3. 48. N. Lat. 49. 46.

**MEZIRIAC** (Claude Gaspar Bucket Sieur de), one of the most ingenious men of the 17th century, was born at Bresse, of an ancient and noble family. He was a good poet in French, Italian, and Latin; an excellent grammarian, a great Greek scholar, and an admirable critic. He was well versed in the controversies, both in philosophy and religion; and was deeply skilled in algebra and geometry, of which last he gave proof by publishing the six books of Diophantes, enriched with a very able Commentary and Notes. In his youth he spent a considerable time at Paris and at Rome: at which last place he wrote a small collection of Italian poems, in competition with Vaugelas, who was there at the same time; among which there are imitations of the most beautiful families contained in the eight first books of the *Æneid*. He also translated Ovid's Epistles; a great part of which he illustrated with very curious Commentaries of his own. While he was at Paris, they talked of making him preceptor of Lewis XIII.: upon which he left the court in great haste, and afterwards declared that he had never felt so much pain upon any occasion of his life; for he seemed to have already upon his shoulders the important weight of the whole kingdom. He undertook the translation of all Plutarch's works, with notes; which he had brought nearly to a conclusion, when he died at Bourg, in Bresse, anno 1638, at 45 years of age. He left behind him several finished works, that were not printed.

**MEZZOTINTO**, a particular manner of representing figures on copper, so as to form prints in imitation of painting in Indian ink.

The manner of making mezzotintos is very different from all other kinds of engraving and etching; since, instead of forming the figures with lines and scratches made with the point of a graver, or by means of aquafortis, they are wholly formed by scraping and burnishing. Mezzotintos are made in the following manner: Take a well-polished copperplate, and beginning at the corner, rake or furrow the surface all over with a knife or instrument made for the purpose, first one way, and then the other, till the whole is of a regular roughness, without the least smooth part to be seen; in which state, if a paper was to be worked off from it at the copper-plate press, it would be all over black. When this is done, the plate is rubbed over with charcoal, black chalk, or black lead, and then the design is drawn with white chalk; after which the out-lines are traced out, and the plate finished by scraping off the roughness, so as to leave the figure on the plate. The outlines and deepest shades are not scraped at all; the next shades are scraped but little, the next more;

and so on, till the shades gradually falling off, leave the paper white, in which places the plate is nearly burnished.

By an artful disposition of the shades and different parts of a figure on different plates, mezzotintos have been printed in colours, so as nearly to resemble very beautiful paintings.

**MIASMA**, among physicians, a particular kind of effluvia, by which certain fevers, particularly intermittents, are produced. See **MEDICINE**, n° 139.

**MICA**, GLIMMER, in natural history, a genus of talcs. See **TALC**.

**MICAH**, or *The Book of MICAH*, a canonical book of the Old Testament, written by the prophet Micah, who is the seventh of the twelve lesser prophets. He is cited by Jeremiah, and prophesied in the days of Josiah, Ahaz, and Hezekiah. He censures the reigning vices of Jerusalem and Samaria, and denounces the judgments of God against both kingdoms. He likewise foretells the confusion of the enemies of the Jews, the coming of the Messiah, and the glorious success of his church.

**MICHAEL** (Angelo Buonarroti). See **ANGELO**.

**MICHAEL** (Angelo da Caravaggia). See **ANGELO**, and **CARAVAGGIO**.

**Mount MICHAEL**, one of the most celebrated state-prisons of France, lies about 20 miles from Granville. It is a rock situated in the middle of the bay of Avranches; and is only accessible at low water. Nature has completely fortified one side, by its craggy and almost perpendicular descent, which renders it impracticable to mount it by any address or courage, however consummate. The other parts are surrounded by walls fenced with semilunar towers after the Gothic manner; but sufficiently strong, together with the advantages of its situation, to render it impregnable to any attack. At the foot of the mountain begins a street or town, which winds round its base to a considerable height. Above are chambers where state-prisoners are kept, and where there are other buildings intended for residence. On the summit is erected the abbey itself, occupying a prodigious space of ground, and of a strength and solidity equal to its enormous size; since it has for many centuries withstood all the injuries of the weather, to which it is so much exposed. In an apartment, called the *Salé de Chivalerie*, the knights of St Michael used to meet in solemn convocation on important occasions. They were the defenders and guardians of this mountain and abbey, as those of the temple, and of St John of Jerusalem, were of the holy sepulchre. The hall in which they met is very spacious, but rude and barbarous. At one end is a painting of the archangel, the patron of their order; and in this hall Lewis XI. first instituted and invested with the insignia of knighthood the chevaliers of the cross of St Michael. There is a miserable dark apartment, or rather dungeon, in which many eminent persons were formerly confined. In the middle of it is a cage, composed of prodigious bars of wood; and the wicket which gives entrance into it is 10 or 12 inches in thickness. The inside of it comprises about 12 or 14 feet square, and it is nearly 20 in height. Towards the latter end of the last century, a certain newswriter in Holland, who had presumed to print some very severe and sarcastic reflections on Madame de

Miasma  
Michael,

Michael. Maintenon, was confined in this place. Some months after his publication, he was induced, by a person sent expressly for that purpose, to make a tour into French Flanders. The moment he had quitted the Dutch territories, he was put under arrest; and immediately, by his majesty's express command, conducted to Mount Michael, where he was shut up in this cage. Here he lived upwards of 23 years; and here he at length expired. During the long nights of winter, no candle or fire was allowed him. He was not permitted to have any book. He saw no human face, except the goaler; who came once every day to present him, through a hole in the wicket, with his little portion of bread and wine. No instrument was given him with which he could destroy himself: but he found means at length to draw out a nail from the wood, with which he engraved, or cut on the bars of his cage, certain fleurs de lis and armorial bearings, which formed his only employment and recreation. They are very curiously performed, considering the rudeness of his tool.

The subterraneous chambers in this mountain are said to be so numerous, that the jailors themselves do not know them. There are certain dungeons called *oubliettes*, into which they were accustomed anciently to let down malefactors guilty of very heinous crimes: they provided them with a loaf of bread and a bottle of wine, and then they were totally forgotten, and left to perish by hunger in the dark vaults of the rock. This punishment, however, has not been inflicted by any king in the last or present century.

Here also is a remarkable chamber, in one corner of which is a kind of window; between this and the wall of the building is a very deep space, of near 100 feet perpendicular, at the bottom of which is another window opening to the sea. It is called the *Hole of Montgomery*; and the history of it is as follows: In the year 1559, Henry II. king of France was unfortunately killed at a tournament by the count de Montgomery †. He was a Huguenot; and having escaped the massacre of Paris, made head against the royal forces in Normandy, supported by queen Elizabeth with arms and money. Being driven from his fortresses in these parts, he retired to a rock called the *Tombelaine*. This is another similar to Mount Michael; only three quarters of a league from it, and of nearly equal dimensions. At that time there was a castle upon it, which hath since been demolished, and of which scarce any vestiges now remain. From this fortress, accessible only at low-water, he continually made excursions, and annoyed the enemy, who never dared to attack him. He coined money, laid all the adjacent country under contribution, and rendered himself universally dreaded. Desirous, however, to surprise Mount Michael, he found means to engage one of the monks resident in the abbey; who promised to give him the signal for his enterprise by displaying a handkerchief. The monk having made the signal, betrayed him, and armed all his associates, who waited Montgomery's arrival. The chieftain came, attended by 50 chosen soldiers, all desperate, and capable of any attempt. They crossed the sand; and having placed their scaling-ladders, mounted one by one. As they came to the top, they were dispatched, each in turn, without noise. Montgomery, who followed last, discovered the per-

fidy, and escaped with only two of his men, with whom he regained the *Tombelaine*. They preserve with great care the ladders and grappling irons used on this occasion. The count was at last besieged and taken prisoner, by the marechal de Matignon, in 1574, at Domfront in Normandy; and Catharine de Medicis, who hated him for having been, though innocently, the cause of her husband's death, caused him to be immediately executed.

The church of Mount Michael is a great curiosity. It stands on nine pillars of most enormous dimensions, built on the solid rock. Each of them appear to be about 25 feet in circumference: besides these, there are two others much inferior in size, on which the centre of the church rests, and over which is the tower. The following is the legendary account of the origin of this church: In the reign of Childbert II. there was a bishop of Avranches named *St Aubert*. To this holy man the archangel Michael was pleased to appear one night, and ordered him to go to this rock to build a church. *St Aubert* treated this as a dream; upon which the angel appeared a second time; and being still disobeyed, he returned a third time; when, by way of imprinting his command upon the faint's memory, he made a hole in his skull, by touching it with his thumb. The skull is still preserved in the treasury of the church. It is inclosed in a little shrine of gold, and a crystal, which opens over the orifice, admits the gratification of curiosity by the minutest examination of it. The hole is of a size and shape proportionable to the thumb said to have produced it; but it is impossible to determine whether it has been really made by a knife, or any other way. It is not to be supposed that the faint would forget such a sensible mark of the angel's displeasure; he therefore immediately repaired to the rock, and constructed a small church, as he had been commanded. Here, however, true history supplies the place of fable; and informs us, that it was in 966 when Richard the second duke of Normandy began to build the abbey. It was completed about the year 1070, under William the Conqueror, though many other additions were made by succeeding abbots.

In the treasury of the church are innumerable other relics; among which some few have a real and intrinsic value. There is a fine head of Charles VI. of France, cut in a crystal, and the representation of a cockle-shell in gold, weighing many pounds, given by Richard II. duke of Normandy when he founded the abbey. There is an arm said to belong to *St Richard* king of England; but who this saint was, must be very difficult to determine.

MICHAELMAS, or *Feast of St Michael*, and *all Angels*, a festival of the Christian church, observed on the 29th of September.

The Scripture account of Michael is, That he was an archangel, who presided over the Jewish nation, as other angels did over the Gentile world, as is evident of the kingdoms of Persia and Greece; that he had an army of angels under his command; that he fought with the Dragon, or Satan and his angels; and that, contending with the devil, he disputed about the body of Moses.

As to the combat between Michael and the Dragon, some authors understand it literally, and think it means the expulsion of certain rebellious angels, with  
their

† See France, no 80.



MICROMETERS.

Fig. 1.

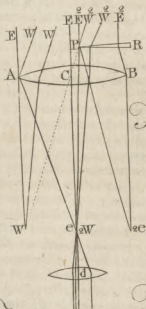
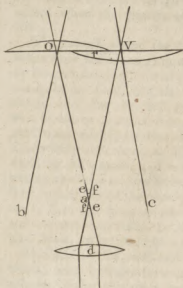


Fig. 2.

Fig. 3.

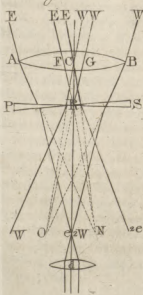


Fig. 4.

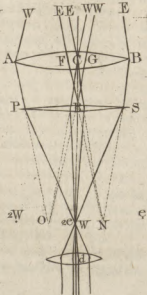


Fig. 5.



Fig. 6.

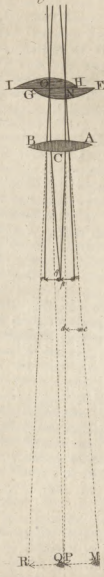
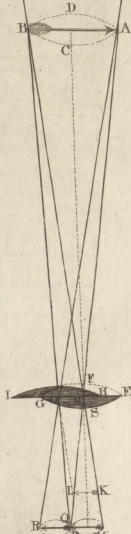
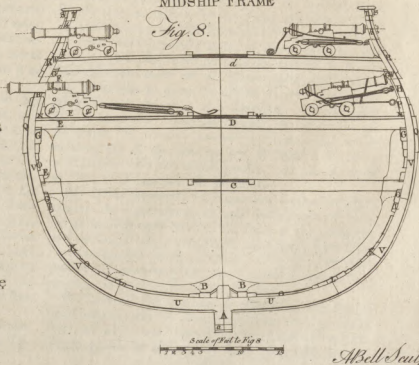


Fig. 7.

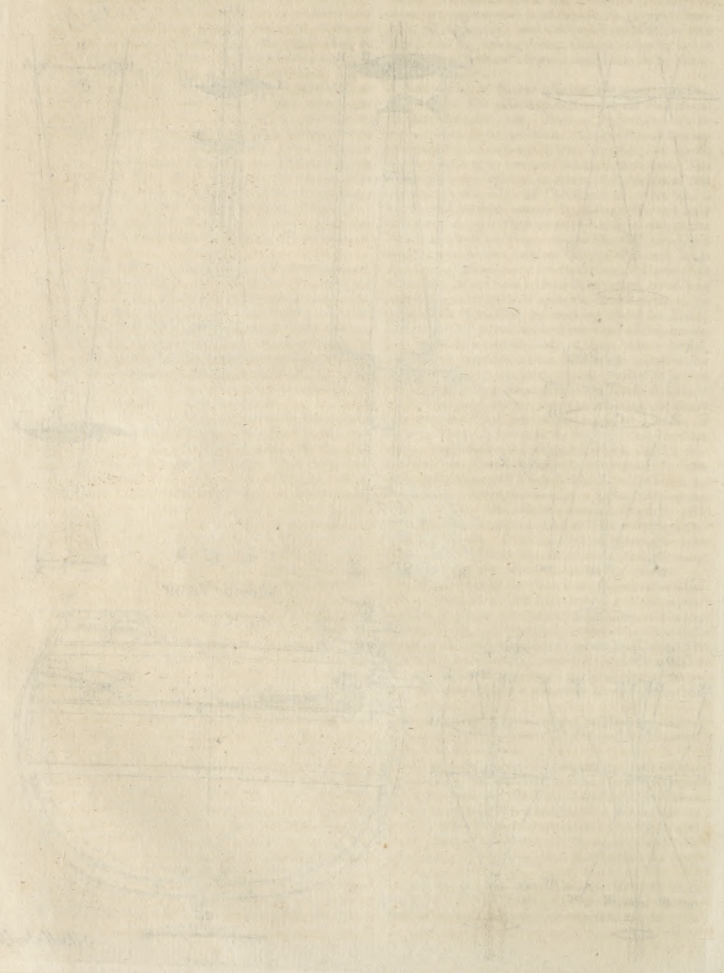


MIDSHIP FRAME

Fig. 8.



Abell Sculp.



Microscopium their head or leader, from the presence of God. Others take it in a figurative sense; and refer it, either to the contest that happened at Rome between St Peter and Simon Magus, in which the apostle prevailed over the magician; or to those violent persecutions, under which the church laboured for 300 years, and which happily ceased when the powers of the world became Christian.

The contest about the body of Moses is likewise taken both literally and figuratively. Those who understand it literally, are of opinion, that Michael, by the order of God, hid the body of Moses after his death, and that the devil endeavoured to discover it, as a fit means to entice the people to idolatry by a superstitious worship of his relics. But this dispute is figuratively understood to be a controversy about rebuilding the temple, and restoring the service of God among the Jews at Jerusalem, the Jewish church being fitly enough styled the *body of Moses*. It is thought by some, that this story of the contest between Michael and the devil was taken by St Jude out of an apocryphal book, called the *Assumption of Moses*.

MICROCOSM, a Greek term signifying the *little world*; used by some for man, as being supposed an epitome of the universe or great world.

MICROGRAPHY, the description of objects too minute to be viewed without the assistance of a microscope. See *MICROSCOPIC Objects*.

MICROMETER, an instrument, by the help of which the apparent magnitudes of objects viewed thro' telescopes or microscopes are measured with great exactness.

The first micrometers were only mechanical contrivances for measuring the image of an object in the focus of the object-glass. Before these contrivances were thought of, astronomers were accustomed to measure the field of view in each of their telescopes, by observing how much of the moon they could see through it, the semidiameter being reckoned at 15 or 16 minutes; and other distances were estimated by the eye, comparing them with the field of view. Mr Gascoigne, an English gentleman, however, fell upon a much more exact method, and had a treatise on Optics prepared for the press; but he was killed during the civil wars, in the service of Charles I. and his manuscript was never found. His instrument, however, fell into the hands of Mr R. Townly, who says, that by the help of it he could mark above 40,000 divisions in a foot.

Mr Gascoigne's instrument being shewn to Dr Hooke, he gave a drawing and description of it, and proposed several improvements in it, which may be seen in *Phil. Transf. abr. Vol. I. p. 217*. Mr Gascoigne divided the image of an object, in the focus of the object-glass, by the approach of two pieces of metal, ground to a very fine edge, in the place of which Dr Hooke would substitute two fine hairs stretched parallel to one another. Two other methods of Dr Hooke's, different from this, are described in his *Posthumous Works, p. 497, 498*. An account of several curious observations that Mr Gascoigne made by the help of his micrometer, particularly in the mensuration of the diameters of the moon and other planets, may be seen in the *Phil. Transf. Vol. XLVIII. p. 190*.

Mr Huygens, as appears by his *System of Saturn, published in 1659*, used to measure the apparent dia-

micrometers of the planets, or any small angles, by first measuring the quantity of the field of view in his telescope; which, he says, is best done by observing the time which a star takes up in passing over it, and then preparing two or three long and slender brass plates, of various breadths, the sides of which were very straight, and converging to a small angle. In making use of these pieces of brass, he made them slide in two slits, that were made in the sides of the tube, opposite to the place of the image, and observed in what place it just covered the diameter of any planet, or any small distance that he wanted to measure. It was observed, however, by Sir Isaac Newton, that the diameters of planets, measured in this manner, will be larger than they should be, as all lucid objects appear to be, when they are viewed upon dark ones.

In the *Ephemerides of the Marquis of Malvasia, published in 1662*, it appears that he had a method of measuring small distances between fixed stars, and the diameters of the planets, and also of taking accurate draughts of the spots of the moon; and this was by a net of silver wire, fixed in the common focus of the object and eye-glass. He also contrived to make one of two stars to pass along the threads of this net, by turning it, or the telescope, as much as was necessary for that purpose; and he counted, by a pendulum-clock, beating seconds, the time that elapsed in its passage from one wire to another, which gave him the number of the minutes and seconds of a degree contained between the intervals of the wires of his net, with respect to the focal length of his telescope.

In 1666, Messrs Auzout and Picard published a description of a micrometer, which was nearly the same with that of the Marquis of Malvasia, excepting the method of dividing it, which they performed with more exactness by a screw. In some cases they used threads of silk, as being finer than silver wires. Dechales also recommends a micrometer consisting of fine wires, or silken threads, the distances of which were exactly known, disposed in the form of a net, as peculiarly convenient for taking a map of the moon.

M. de la Hire says, that there is no method more simple or commodious for observing the digits of an eclipse than a net in the focus of the telescope. These, he says, were generally made of silk threads; and that for this particular purpose six concentric circles had also been made use of, drawn upon oiled paper; but he advises to draw the circles on very thin pieces of glass with the point of a diamond. He also gives several particular directions to assist persons in the use of them. In another memoir he shews a method of making use of the same net for all eclipses, by using a telescope with two object-glasses, and placing them at different distances from one another.

M. Cassini invented a very ingenious method of ascertaining the right ascensions and declinations of stars, by fixing four cross hairs in the focus of the telescope, and turning it about its axis, so as to make them move in a line parallel to one of them. The difficulty there was in accomplishing this was entirely removed by a mechanical contrivance of Dr Bradley.

M. Lewenhoeck's method of estimating the size of small objects was by comparing them with grains of sand, of which 100 placed in a line took up an inch. These grains he laid on the same plate with his ob-

Micrometer jets, and viewed them at the same time. Dr Jurin's method was similar to this of M. Lewenhoek; for he found the diameter of a piece of fine silver-wire, by wrapping it as close as he could about a pin, and observing how many rings made an inch. For he used this wire in the same manner as Lewenhoek used his sand.

Mr Martin, in his Optics, recommends such a micrometer to a microscope as had been applied to telescopes; for he advises to draw a number of parallel lines on a piece of glass, with the fine point of a diamond, at the distance of  $\frac{1}{10}$  of an inch from one another, and to place it in the focus of the eye-glass. By this method Dr Smith contrived to take the exact draught of objects viewed by a double microscope. For he advises to get a lattice, made with small silver wires or small squares, drawn upon a plain glass by the strokes of a diamond, and to put it into the place of the image formed by the object-glass. Then by transferring the parts of the object, seen in the squares of the glass or lattice, upon similar corresponding squares, drawn on paper, the picture may be exactly taken. Mr Martin also introduced into compound microscopes another micrometer, consisting of a screw.

Dr Hooke used to look upon the magnified object with one eye, while, at the same time, he viewed other objects placed at the same distance with the other eye. In this manner he was able, by the help of a ruler, divided into inches and small parts, and laid on the pedestal of the microscope, to call, as it were, the magnified appearance of the object upon the ruler, and thereby exactly to measure the diameter which it appeared to have through the glass; which being compared with the diameter as it appeared to the naked eye, easily shewed the degree in which it was magnified. This, says Mr Baker, is a ready and good method for many objects; and he declares, from his own experience, that a little practice will render it exceedingly easy and pleasant.

We are obliged to Dr Hooke for an excellent method of viewing the sun without injuring our eyes. For this purpose he contrived that the rays should be reflected from one plane to another, till it was so much weakened that the eye might receive it with great safety and pleasure. This method is much preferable to that of looking at the sun through a smoky or coloured glass, which gives it a red and disagreeable hue. His discourse on this subject was read before the Royal Society June 28 1675.

These micrometers, however, have several considerable defects. In particular, it is not easy to measure with them objects that are in motion, or those which are too large to come within the field of view; so that the diameters of the sun and moon cannot well be measured with them to any great degree of exactness. Another method was found of measuring the apparent magnitude of the object, free from the inconveniences above mentioned, by means of a telescope furnished with two object-glasses. This ingenious method was hit upon about the same time both by Mr Servington Sauvery and the celebrated M. Bouguer.

In this instrument, both object-glasses are of equal focal distance, and placed one of them by the side of the other; so that the same eye-glass may serve for them

both. By this means two distinct images of an object are formed in the focus of the eye-glass; and since the distance of these images depends upon the distance at which the two object-glasses are placed from one another, it may be measured with great accuracy. Nor is it necessary that the whole disc of the sun or moon come within the field of view; since, if the images of a small part of the disc be formed by each object-glass, the whole diameter may easily be computed, by their position with respect to one another. For if the object be large, the images will approach towards, or perhaps even lie over one another. And the object-glasses being moveable, the two images may always be brought exactly to touch one another, and the diameter may be computed from the known distance of the centres of the two glasses.

Another advantage attending this instrument is, that by having a common micrometer in the focus of the eye-glass, when the two images of the sun or moon are made in part to cover one another, that part which is common to both the images may be measured with great exactness, as being viewed upon a ground that is only one half less luminous than itself; whereas, in general, the heavenly bodies are viewed upon a dark ground, and on that account are imagined to be larger than they really are. By a small addition to this instrument, provided it be of a moderate length, M. Bouguer thought it very possible to measure angles of three or four degrees; which is of particular consequence in taking the distance of stars from the moon.

Mr Sauvery's paper containing a very particular description of his construction of this instrument was read at the Royal Society October 27. 1743, and M. Bouguer's account of his instrument which he called an *heliometer* is contained in the Memoirs of the Royal Academy of Sciences for the year 1748, p. 15.

A very great improvement was made in this kind of micrometer by Mr Dollond; for, instead of two complete object-glasses, he used only one, cut into two equal parts, one of them sliding by the other. Each half of this object-glass will give a separate and distinct image; and as the distance at which their centres are placed from one another may be exactly ascertained, the same uses may be made of them as of two entire object-glasses, and the application of them is much more commodious.

But the ground or reason of this new micrometer, as applied to the refractory or reflecting telescope, may be illustrated by figures, as follows:

Let ABCD represent any very distant object, as the sun, &c. and AB its diameter; also let EFGS represent the object-glass consisting of two segments EFG and ESG divided through the centre N in the right line EG. The angle under which it appears at the end of the telescope will be ANB equal to the angle KNL, under which the image KL is contained. Now, suppose the moveable segment EFG were by a mechanical contrivance drawn off to the position H, the distance of their centres would be NO; and the two lines AN and BO passing through the centres N, O, of the segments, if produced, meet at the focus in L; and since BL and BK do also pass through the centres N and O, and the object being at an indefinitely great distance, the line OL will be parallel

Plate

CLXXV.

Fig. 7.

Micrometer to NK, and consequently the angle NLO is equal to the angle KNL or ANB; that is to say, the angle under which the object appears from the end of the telescope (or to the naked eye), is equal to the angle under which the distance between the two centres of the segments appear from the solar focus of the telescope.

And this will be the case in every distance of an object: for supposing the object AB were at some near distance from the telescope, and subtended the same angle ANB, the only consequence would be, that its image would be formed at a greater distance from the glass, suppose at MP: it would still be contained under the same angle MNP, equal to NLO, as before, upon the supposition that the segment HI and BO produced meets AP in the point P; that is to say, suppose that the segment HI is in such position that the moveable image QR formed by it, exactly coincides with the fixed image MP, formed by the segment ESG.

Fig. 6.

Concerning this vitreous micrometer we may farther observe, that its great excellency consists in this, that it depends solely in measuring the distance of the centres of the two segments, not only when applied alone at the end of a telescope, but even in conjunction with the object-glass of any common telescope; for, let EG and HI represent the two segments, as before, of a glass whose focal distance is very long, suppose, for instance, 50 feet; then, at a small distance from it, let AB represent the object-glass of a common long telescope, whose focal distance of parallel rays is  $Cd$ , or its focus of very distant objects *d.c.* Then this glass, combined with the foregoing segments, will have its focus shortened, and the common focus of both will be in point *q*. Then because the triangles RQq and PNM are similar to the triangles  $rOq$  and  $pNm$  respectively; therefore the images RQ and PM will be similar, and alike posited to the two small images  $rq$  and  $pm$ ; and therefore when these two images are in contact in the focus of the semi-lenses, they will likewise be in contact in the shortened compound focus. And as the centres N and O of the two semi-lenses GE and IH are separated farther from, or brought nearer to, each other, the images in either focus will be moved in similar manner; and when the centres N and O coincide, the images in each focus respectively will also coincide, or become one entire image; the difference in every case being only as to large and small, greater or lesser distance. Consequently, in the micrometer by which those two semi-lenses are moved by each other, the same turns of the screw which measures the angle OPN, and which brings the images into an exact contact in the single focus at  $Q_2$  will be necessary for the same purpose in the compound focus also; so that by this means we have an opportunity of measuring the said angle OPQ, without being obliged to have so great and so unmanageable a length of the telescope.

However, the larger the focal distance of the lens AB is, the more distinct the contact of the images will appear; and because this is the point on which the whole perfection of this micrometer depends, it will be likewise necessary to have it so contrived, when applied to a telescope, that the centres NO may be equally distant from the axis of the telescope or centre

of the aperture on either side; because, in this case, the point of contact in the two images will be just in the centre of the focus, and therefore the most distinct that it possibly can be.

But the application of this micrometer to refracting telescopes will be less convenient than when it is applied to a reflecting telescope; for if it be placed on the open end of the reflecting telescope, then will the rays that tend to form the larger images RQ and PM be incident upon the larger speculum AB, and from thence reflected to a compound focus, where the similar images  $rq$  and  $pm$  will be formed as before; the rays proceeding from these two images to the smaller speculum  $a b$ , will be reflected back through the hole of the larger, to form the images QR and PM, which likewise will fall in contact in the focus of the eye-glass DC, where it will be distinctly perceived by the eye at I. This contact will likewise be shewn in the focus of the eye-glass, if the centres O and N are properly disposed, as before-mentioned.

Fig. 5.

From what has been said, the general rationale of this micrometer will evidently appear; but one thing must not pass unregarded in an affair of such moment and consequence as the measuring these small angles in the science of astronomy. It has been customary to suppose, that the focus of a lens, or the local distance of rays parallel to its axis, is equal to the radius in a double and equally convex lens. But this is too great an error not to be noticed here; for in different sorts of glass there is found a different refractive power, and the focus of parallel rays is at a different distance in each; but this distance in no sort of glass is equal to the radius, but falls short of it more or less. Now the foregoing demonstration regards the radius, and not the focal distance of parallel rays.

With regard to the planets, as Jupiter is the largest of all, and subtends an angle to the eye of  $3' 12''$ , the diameter of his image in the focus of a 50 foot glass will be about half an inch; and that will be the utmost distance to which the centres of the segments will be required to be separated for measuring the apparent diameters of the planets.

But for a heliometer, the diameter of the sun, being near 10 times as great as that of Jupiter, will require the centres of the segments in a glass of 40 or 50 feet focus to be removed from each other at least to the distance of four or five inches; and to take in the whole system of Jupiter's moons, the distance of the centres will be required much larger; and therefore, for such purposes, the segments of glasses of a less focal length must be used.

But, valuable as the object-glass micrometer undoubtedly is, some difficulties have been found in the use of it, owing to the alterations in the focus of the eye, which are apt to cause it to give different measures of the same angle at different times. For instance, in measuring the sun's diameter, the axes of the pencils of rays, which come through the two segments of the object-glass from contrary limbs of the sun, crossing one another at the focus of the telescope under an angle equal to that of the sun's diameter, the union of the limbs of the two images of the sun cannot appear perfect unless the eye be disposed to

Micrometer see objects distinctly which are placed at the point of intersection. But if the eye be disposed to see objects distinctly, which are placed nearer the object-glasses than the intersection is, the two limbs will appear separated by the interval of the axes of the pencils in that place; and if the eye be disposed to see objects distinctly, which are placed farther from the object-glasses than the intersection is, the two limbs will appear to encroach upon each other by the distance of the axes of the pencils, after their crossing, taken at that place.

Fig. 1. To explain this, let  $OV$  represent the centres of the two semicircular glasses of the object-glass micrometer, separated to the distance  $OV$  from each other, subtending the angle  $OaV$ , equal to the sun's diameter, at the point  $a$ , which is the common focus of the two pencils of rays having  $Oa$  and  $Va$  for their axes, namely, those proceeding from contrary sides of the sun, and passing through the contrary semi-circles; and let  $d$  be the eye-glass. It is evident, that if  $d$  be properly placed to give distinct vision of objects placed at the point  $a$ , the rays  $Oa$ ,  $Va$ , as well as all the other rays belonging to those pencils, will be collected into one point upon the retina of the eye; and consequently, the two opposite limbs of the two images of the sun will seem to coincide, and the two images of the sun to touch one another externally. But if the state of the eye should alter, the place of the eye-glass remaining the same, the eye will be no longer disposed to see the image formed at the point  $a$  distinctly, but to see an object placed at  $ef$ , nearer to or farther from the object-glass distinctly; and therefore an image will be formed on the retina exactly similar to the somewhat confused image formed by the rays on a plane perpendicular to their course at  $ef$ . Consequently, as the two cones of solar rays,  $bOa$ ,  $cVa$ , formed by the two semi-circles, are separated or encroach upon one another at this point of the axis by the distance  $ef$ , the two images of the sun will not seem to touch one another externally, but to separate or to encroach upon one another by the interval  $ef$ . The error hereby introduced into the measure of the sun's diameter will be the angle  $erf$ , subtended by  $ef$  at  $r$  the middle point between  $O$  and  $V$ , which is to  $caf$  or  $OaV$ , the sun's apparent diameter, as  $e$  to  $er$ , or even to  $ar$ , on account of the smallness of  $ac$  with respect to  $ar$ .

These considerations concerning the cause of a principal error that has been found in the object-glass micrometer led to an inquiry, whether some method might not be found of producing two distinct representations of the sun, or any other object, which should have the axes of the pencils of rays, by which they are formed, diverging from one and the same point, or nearly so: and it occurred to Mr. Maskelyne, that this might be done by the refraction of a prism placed to receive part of the rays proceeding from the object, either before or after their refraction through the object-glass of a telescope. If the prism be placed without the object-glass, the rays that are refracted through it will make an angle with the rays that pass beside it equal to the refraction of the prism; and this angle will not be altered by the refraction of the object-glass afterwards. Consequently, two images of an object will be represented, and the prism so applied will en-

able us to measure the apparent diameter of any object, or any other angular distance which is equal to the refraction of the prism. But if the prism be placed within the object-glass, that is to say, between the object-glass and eye-glass, the angle measured by the instrument will vary according to the distance of the prism from the focus of the object-glass, bearing the same ratio to the refraction of the prism, as the distance of the prism from the focus bears to the focal length of the object-glass.

Let  $ACB$  (fig. 2.) represent the object-glass and  $d$  the eye-glass of a telescope, and  $PR$  a prism placed to intercept part of the rays coming from an object, suppose the sun, before they fall on the object-glass. The rays  $EE$  proceeding from the eastern limb of the sun, and refracted through the object-glass  $ACB$  without passing through the prism, will form the corresponding point of the sun's image at  $e$ ; and the rays  $WW$  proceeding in like manner from the western limb of the sun will be refracted to form the corresponding point of the sun's image at  $W$ . But the rays  $2E$ ,  $2E$ ,  $2W$ ,  $2W$ , proceeding in like manner from the eastern and western limbs of the sun, and falling on the prism  $PR$ , and thence refracted to the object-glass  $ACB$ , will, after refraction through it, form the corresponding points of the sun's image at  $2e$ ,  $2W$ . Let the refraction of the prism be equal to the sun's apparent diameter: in this case, at whatever distance the prism be placed beyond the object-glass, the two images of the sun  $We$ ,  $2W 2e$ , will touch one another externally at the point  $e2W$ ; for the rays  $2W$ ,  $2W$ , proceeding from the western of the sun being inclined to the rays  $EE$  proceeding from the eastern limb in the angle of the sun's apparent diameter, will, after suffering a refraction in passing through the prism equal to the sun's apparent diameter, emerge from the prism and fall upon the object-glass parallel to the rays  $EE$ , and consequently will have their focus  $2W$  coincident with the focus  $e$  of the rays  $EE$ ; and therefore the two images of the sun  $We$ ,  $2W 2e$ , will touch one another externally at the point  $e 2W$ , and the instrument will measure the angle  $EC2W$ , and that only.

But if the prism be placed within the telescope, the angle measured by the instrument will be to the refraction of the prism as the distance of the prism from the focus of the object-glass is to the focal distance of the object-glass: or if two prisms be used to form the two images, with their refracting angles placed contrary ways, as represented in fig. 3. and 4. the angle measured will be to the sum of the refractions of the prism, as the distance of the prisms from the focus of the object-glass is to the focal distance of the object-glass. For let  $ACB$  (fig. 3.) represent the object-glass, and  $d$  the eye-glass of a telescope, and  $PR$ ,  $RS$ , two prisms interposed between them, with their refracting angles turned contrary ways, and the common sections of their refracting planes touching one another at  $R$ . The rays proceeding from an object, suppose the sun, will be disposed, by the refraction of the object-glass, to form an image of the sun at the focus; but part of them falling on one prism, and part on the other, will be thereby refracted contrary ways, so as to form two equal images  $We$ ,  $2W 2e$ , which, if the refractions of the prisms be of proper quantities, will touch one another externally at the point  $e 2W$ .

Let

Fig. 1. MUREX. N<sup>o</sup> 1.



N<sup>o</sup> 2.



N<sup>o</sup> 3.



N<sup>o</sup> 4.



Fig. 3. MELLAGRIS  
or *Stomel flossant*



Fig. 2.  
MONODON.

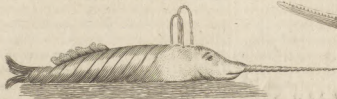


Fig. 5.  
MYA. N<sup>o</sup> 1.



N<sup>o</sup> 2.



N<sup>o</sup> 3.

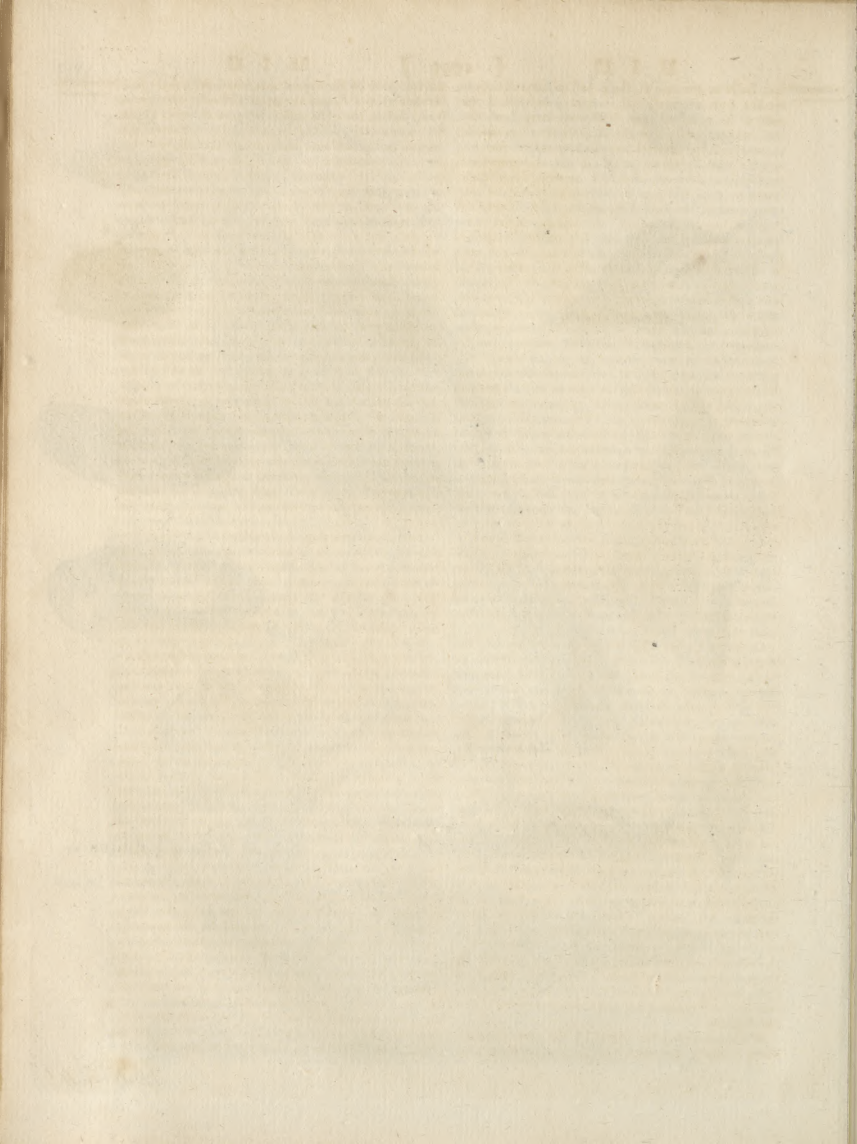


N<sup>o</sup> 4.



Fig. 4. MERGUS or  
*round Crested Duck*







**Micrometer** Let ECN be the axis of the pencil of rays EE proceeding from the fun's eastern limb; and WCO the axis of the pencil of rays WW proceeding from the fun's western limb; and the point N the place where the image of the fun's eastern limb would be formed, and the point O where that of the western limb would be formed, were not the rays diverted from their course by the refractions of the prisms. But by this means part of the rays EE, which were proceeding to N, falling on the prism PR, will be refracted to form an image of the fun's eastern limb at *e*, while others of the rays EE, which fall on the prism RS, will be refracted to form an image of the fun's eastern limb at *ze*. In like manner, part of the rays WW, which were proceeding to form an image of the fun's western limb at O, falling on the prism RS, will be refracted to form an image of the fun's western limb at *zW* coincident with *e*, the point of the image correspondent to the fun's eastern limb; while others of the rays WW, which fall on the prism PR, will be refracted to form the image of the fun's western limb at W. The two images *We*, *zW ze*, are supposed to touch one another externally at the point *e**zW*. The ray EFR, which belongs to the axis ECN, and is refracted by the prism PR to *e*, undergoes the refraction NRe, which (because small angles are proportional to their sines, and the sine of NRe is equal to the sine of its supplement NRC), is to NCR as NC or Ce is to NR or Re. In like manner, the ray WGR, which belongs to the axis WCO, and is refracted by the prism RS to *zW* or *e*, undergoes the refraction ORe, which is to OCe as OC or Ce is to RO or Re; therefore, by composition, ORN the sum of the refractions ORe, NRe, is to OCN the sum of the angles OCe, NCe, or the fun's apparent diameter, as Ce to Re; that is, as the focal distance of the object-glass to the distance of the prisms from the focus of the object-glass.

Or let the prisms PR, RS, be placed with their refracting angles P, S, turned from one another as in fig. 4: the refraction of the prism PR will transfer the image of the fun from ON to We, and the refraction of the prism RS will transfer the image ON to *zW ze*, the two images *zW ze*, We, touching one another externally at the point *zWe*. Let ECN, WCO, be the axes of the pencils of rays proceeding from the two extreme limbs of the fun, and N, O, the points where the images of the fun's eastern and western limbs would be formed by the object-glass, were it not for the refraction of the prisms; the ray EFR, which belongs to the axis ECN, and is refracted by the prism RS, to *ze*, undergoes the refraction NR*e*; and the ray WGR, which belongs to the axis WCO, and is refracted by the prism PR to W, undergoes the refraction ORW. Now NC*e*, part of the angle measured, is to NR*e*, the refraction of the prism RS, as RW to CW; and OCW, the other part of the angle measured, is to ORW, the refraction of the prism PR, in the same ratio of RW to CW: therefore OCN, the whole angle measured, is to ORN, the sum of the refractions of the two prisms, as RW to CW; that is, as the distance of the prisms from the focus of the object-glass to the focal distance of the object-glass.

When the prisms are placed in the manner represented in fig. 3. the point *e* of the image We is illu-

minated only by the rays which fall on the object-glass between A and F, and the point *zW* only by the rays which fall on the object-glass between B and G. Now the angles CRF, CRG, equal to the refractions of the prisms, being constant, the spaces FC, CG, will increase in proportion as the distances RF, RG, increase, and the spaces AF, GB, diminish as much; and therefore the images at the point of mutual contact *e**zW* will be each illuminated by half the rays which fall on the object-glass when the prisms are placed close to the object-glass, but will be enlightened less and less the nearer the prisms are brought to the focus of the object-glass.

But when the prisms are placed in the manner shewn in fig. 4. the images at the point of contact, as the prisms are removed from the object-glass towards the eye-glass, will be enlightened with more than half the rays that fall on the object-glass, and will be more enlightened when the prisms are brought to the focus itself; for the point *ze* of the image *zW ze* will be enlightened by all the rays EE that fall on the object-glass between B and G, and the point W of the image We will be enlightened by all the rays WW which fall on the object-glass between A and G. But the difference of the illuminations is not very considerable in achromatic telescopes, on account of the great aperture of the object-glass; as the greatest space FG is to the focal distance of the object-glass as the sum of the sines of the refractions of the prisms is to the radius.

There is a third way, and perhaps the best, of placing the prism, so as to touch one another along their sides which are at right angles to the common sections of their refracting planes. In this disposition of the prisms the images will be equally enlightened, namely, each with half the rays which fall on the object-glass, wherever the prisms be placed between the object-glass and eye-glass.

From what has been shewn it appears, that this instrument, which may be properly called the *prismatic micrometer*, will measure any angle that does not exceed the sum of the refractions of the prisms, excepting only very small angles, which cannot be taken with it on account of the vanishing of the pencils of rays at the juncture of the two prisms near the focus of the object-glass; that it will afford a very large scale, namely, the whole focal length of the object-glass, for the greatest angle measured by it; and that it will never be out of adjustment; as the point of the scale where the measurement begins (or the point of O) answers to the focus of the object-glass, which is a point for celestial objects, and a point very easily found for terrestrial objects. All that will be necessary to be done, in order to find the value of the scale of this micrometer, will be to measure accurately the distance of the prisms from the focus when the instrument is set to measure the apparent diameter of any object subtending a known angle at the centre of the object-glass, which may be easily found by experiment, as by measuring a base and the diameter of the object observed placed at the end of it, in the manner practised with other micrometers: for the angle subtended by this object will be to the angle subtended by a celestial object, or very remote land-object, when the distance of the prisms from the principal

*Micrometer* cipal focus is the fame as it was found from the actual focus in the terrestrial experiment, as the principal focal distance of the object-glass is to the actual focal distance in the said experiment.

It will probably be the best way in practice, instead of one prism to use two prisms, refracting contrary ways, and so divide the refraction between them (as represented in fig. 3. and 4.). Achromatic prisms, each composed of two prisms of flint and crown-glass, placed with their refracting angles contrary ways, will undoubtedly be necessary for measuring angles with great precision by this instrument: and we can only add with pleasure, that it is found by experiment made with this instrument, as it was executed by Mr Dollond with achromatic prisms, ground with great care for this trial sometime ago, that the images, after refraction through the prisms, appear very distinct; and that observations of the apparent diameters of objects may be taken in the manner here proposed with ease and precision.

Two or more sets of prisms may be adapted to the same telescope, to be used each in their turn, for the more commodious measurement of different angles. Thus it may be very convenient to use one set of prisms for measuring angles not exceeding 36°, and consequently fit for measuring the diameters of the sun and moon, and the lucid parts and distances of the cusps in their eclipses; and another set of prisms to measure angles not much exceeding one minute, and consequently fit for measuring the diameters of all the other planets. This latter set of prisms will be the more convenient for measuring small angles, on account of a small imperfection attending the use of this micrometer, as before mentioned; namely, that angles cannot be measured with it when the prisms approach very near the focus of the object-glass, the pencils of rays being there lost at the point where the prisms touch one another.

Upon the principles that have been here explained, a prism placed within the telescope of an astronomical instrument, adjusted by a plumb-line or level, to receive all the rays that pass through the object-glass, may conveniently serve the purpose of a micrometer, and supersede the use both of the vernier scale and the external micrometer; and the instrument may then be always set to some even division before the observation. Thus the use of a telescopic level may be extended to measure with great accuracy the horizontal refractions, the depression of the horizon of the sea, and small altitudes and depressions of land-objects. Time and experience will doubtless suggest many other useful applications of this instrument.

But the greatest improvement which the micrometer hath yet received is from Dr Maskelyne, who hath invented a catoptric one. This, besides the advantage it derives from the principle of reflection, of not being disturbed by the heterogeneity of light, avoids every defect of other micrometers, and can have no aberration, nor any defect which arises from the imperfection of materials, or of execution, as the extreme simplicity of its construction requires no additional mirrors or glasses to those required for the telescope: and the separation of the image being effected by the inclination of the two specula, and not depending on the focus of any lens or mirror, any al-

teration, in the eye of an observer, cannot affect the *Micrometer* angle measured.

It has, peculiar to itself, the advantages of an adjustment to make the images coincide in a direction perpendicular to that of their motion; and also of measuring the diameter of a planet on both sides the zero, which will appear no inconsiderable advantage to observers who know how much easier it is to ascertain the contact of the external edges of two images than their perfect coincidence. A short explanation of the annexed drawings will make the construction and the properties of this micrometer obvious.

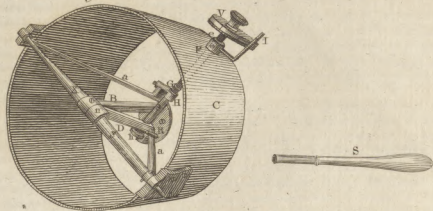
"I divided (says Mr Maskelyne) the small speculum of a reflecting telescope, of Cassegrain's construction, into two equal parts, by a plane across its centre; and by inclining the halves of the speculum to each other on an axis at right angles to the plane that separated them, I obtained two distinct images. The satisfaction I received on the first trial was checked by the apparent impossibility of reducing this principle to practice. The angular separation of the two images in this case being half the angular inclination of the two specula, it required an index of an unmanageable length to allow the quantity of one second of a degree to become visible. Some time afterwards, on revising the principle, I considered, that if both the halves of the mirror turned on their centre of curvature, there could be no alteration in their relative inclination to each other from their motion on this centre; and that any extent of scale might be obtained, by fixing the centre of motion at a proportional distance from the common centre of curvature. This will be better understood from the annexed figure.

"R (fig. 1.) represents the small speculum divided into two equal parts; one of which is fixed on the end of the arm B; the other end of the arm is fixed on a steel axis X, which crosses the end of the telescope C. The other half of the mirror R is fixed on the arm D, which arm at the other end terminates in a socket, that turns on the axis, X; both arms are prevented bending by the braces *aa*. G represents a double screw, having one part *e* cut into double the number of threads in an inch to that of the part *g*: the part *e* having 100 threads in one inch, and the part *g* 50 only. The screw *e* works in a nut F in the side of the telescope, while the part *g* turns in a nut H, which is attached to the arm B; the ends of the arms B and D, to which the mirrors are fixed, are separated from each other by the point of the double screw pressing against the stud *b*, fixed to the arm D, and turning in the nut H on the arm B. The two arms B and D are pressed against the direction of the double screw *eg* by a spiral spring within the part *n*, by which means all shake or play in the nut H, on which the measure depends, is entirely prevented.

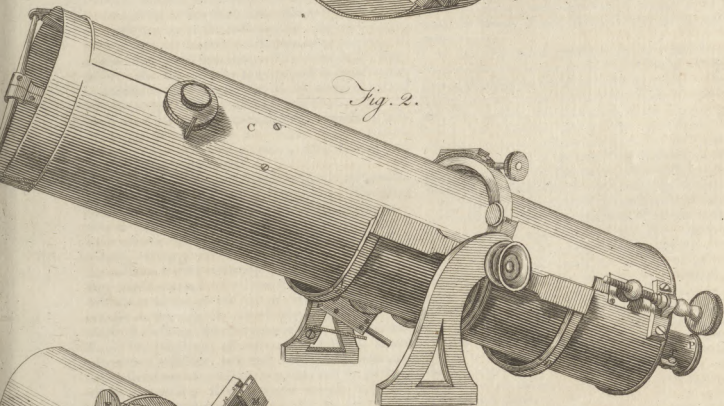
"From the difference of the threads on the screw at *e* and *g*, it is evident, that the progressive motion of the screw through the nut will be half the distance of the separation of the two halves of the mirror; and consequently the half mirrors will be moved equally in contrary directions from the axis of the telescope C.

"The wheel V fixed on the end of the double screw has its circumference divided into 100 equal parts, and numbered at every fifth division with 5, 10, &c. to 100, and the index I shews the motion of the screw with

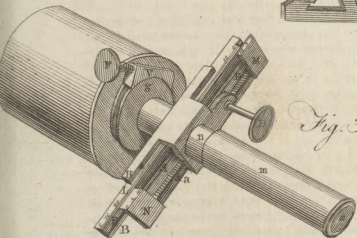
*Fig. 1.*



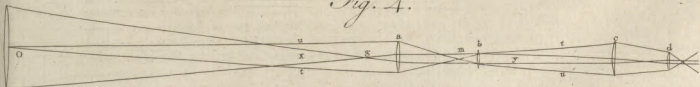
*Fig. 2.*



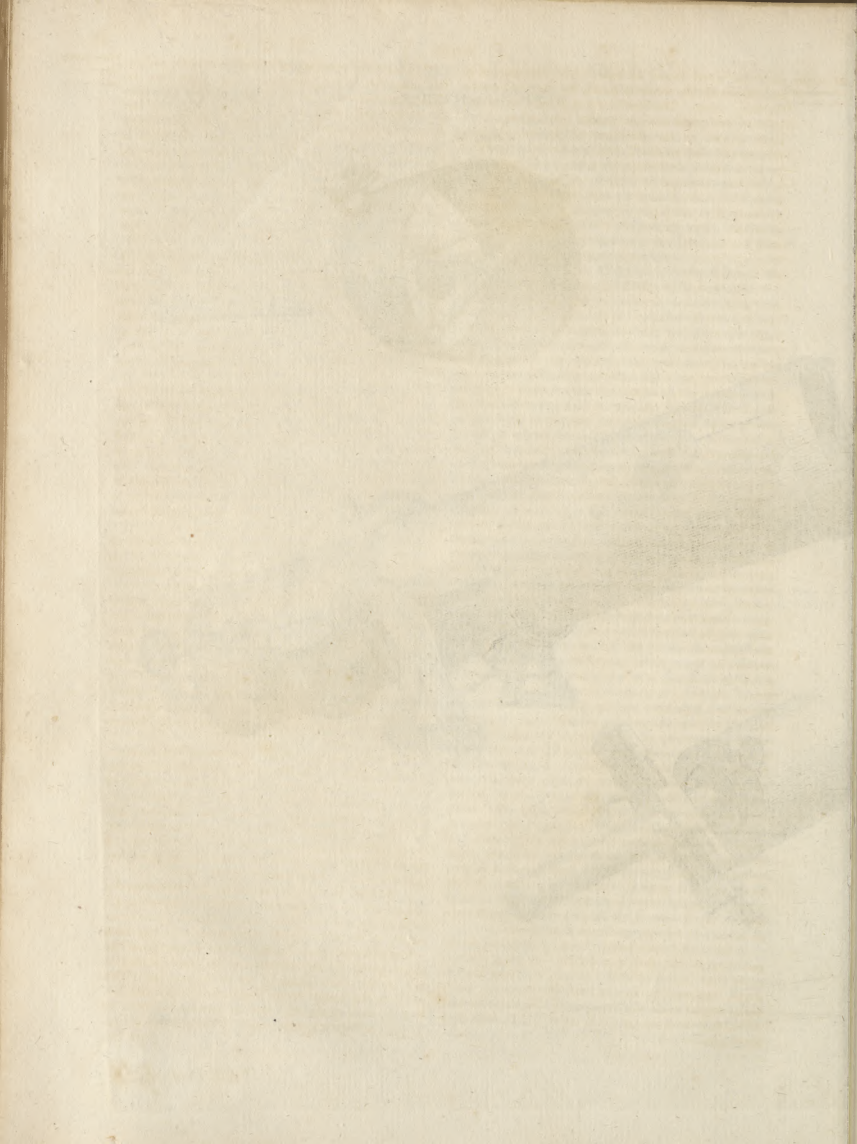
*Fig. 3.*



*Fig. 4.*



*A. Bell sculp.*



Micrometer with the wheel round its axis, while the number of revolutions of the screw is shewn by the divisions on the same index. The steel ferul at R may be turned by the key S, and serves to incline the small mirror at right angles to the direction of its motion. By turning the finger-head T (fig. 2.) the eye-tube P is brought nearer or farther from the small mirror, to adjust the telescope to distinct vision; and the telescope itself hath a motion round its axis for the convenience of measuring the diameter of a planet in any direction. The inclination of the diameter measured with the horizon is shewn in degrees and minutes by a level and vernier on a graduated circle, at the breech of the telescope.

"The method of adjusting and using the catoptric micrometer is too obvious to require any explanation: it is only necessary to observe, that, besides the table for reducing the revolutions and parts of the screw to minutes, seconds, &c. it may require a table for correcting a very small error which arises from the eccentric motion of the half-mirrors. By this motion their centres of curvature will (when the angle to be measured is large) approach a little towards the large mirror: the equation for this purpose in small angles is infensible; but when angles to be measured exceed ten minutes, it should not be neglected. Or, the angle measured may be corrected by diminishing it in the proportion the versed sine of the angle measured, supposing the eccentricity radius, bears to the focal length of the small mirror.

"The telescope to which the catoptric micrometer is applied is of the Cassegrain construction. The great speculum is about 22 inches focus, and bears an aperture of  $5\frac{2}{3}$  inches, which is considerably larger than those of the same focal length are generally made: indeed, the apparent utility of this micrometer makes me wish to see the reflecting telescope meet with further improvements. I believe it would more tend to the advancement of the art of working mirrors, if writers on this subject, instead of giving us their methods of working imaginary parabolas, would demonstrate the properties of curves for mirrors, which, placed in a telescope, will shew images of objects perfectly free from aberration; or, what will yet be more useful in practice, of what forms specula might be made, that the aberration caused by one mirror may be corrected by that of the other. If mathematicians assume *data* which really exist, they must see, that when the two specula of a reflecting telescope are parabolas, they cause a very considerable aberration, which is negative, that is to say, the focus of the extreme ray is longer than those of the middle ones. If the large speculum is a parabola, the small one ought to be an ellipse; but when the small speculum is spherical, which is generally the case in practice, if concave, the figure of the large speculum ought to be an hyperbola; if convex, the large speculum ought to be an ellipse, to free the telescope from aberration.

"This will be easier understood by attending to the positions of the first and second images; when a curve is of such form that lines drawn from each image, and meeting in any part of the curve, make equal angles with the tangent to the curve at that point, it is evident, that such curve will be free from aberration.

"This is the property of a circle when the radiant and image are in the same place; but, when they recede from each other, of an ellipse, of such form that the radiant and image are in the two *foci*, till, one distance becoming infinite the ellipse changes into a parabola, and into an hyperbola when the focus is negative; that is to say, when reflected rays diverge, and the focus is on the opposite side of the mirror.

"These principles made me prefer Cassegrain's construction of the reflecting telescope to either the Gregorian or Newtonian. In the former, errors caused by one speculum are diminished by those in the other.

"From a property of the reflecting telescope (which has not been attended to) that the apertures of the two specula are to each other very nearly in the proportion of their focal lengths, it follows, that their aberrations will be to each other in the same proportion; and these aberrations are in the same direction, if the two specula are both concave; or in contrary directions, if one speculum is concave, and the other convex.

"In the Gregorian construction, both specula being concave, the aberration at the second image will be the sum of the aberrations of the two mirrors; but in the Cassegrain construction, one mirror being concave, and the other convex, the aberration at the second image will be the difference between their aberrations. By assuming such proportions for the *foci* of the specula as are generally used in the reflecting telescope, which is about as 1 to 4, the aberration in the Cassegrain construction will be to that in the Gregorian as 3 to 5.

"I have mentioned these circumstances in hopes of recommending the demonstration of curves suited to the purposes of optics to the attention of mathematicians, which would be of great use to artists.

"I shall conclude with the description of a new micrometer suited to the principle of refraction; being sensible that both principles have their peculiar advantages. Though the former part of this paper proves my partiality to the principle of reflection applied to micrometers, yet the favourable opinion I have of the refracting telescope made me attentively consider some means of applying a micrometer to it, which might obviate the errors complained of in the former part of this paper.

"The application of any lens or medium between the object-glass and its focus must inevitably destroy the distinctness of the image; I therefore have employed for the micrometer-glass, one of the eye-glasses requisite in the common construction of the telescope; but if it should be found necessary to apply an additional eye-glass for the convenience of enlarging the scale, I am able thereby to correct both the colours and spherical aberration of the first eye-glass.

"This micrometer is applied to the erect eye-tube of a refracting telescope, and is placed in the conjugate focus of the first eye-glass: hence arises its great superiority to the object-glass micrometer. It has been before observed, that if a micrometer is applied at the object-glass, the imperfections of its glass are magnified by the whole power of the telescope; but in this position, the image being considerably magnified before it comes to the micrometer, any imperfection in its glass will be magnified only by the remaining eye-glasses,

Micrometer glasses, which in any telescope seldom exceeds five or six times.

“ By this position the size of the micrometer glass will not be the  $\frac{1}{2}$  part of the area which would be required if it was placed in the object-glass; and, notwithstanding this great disproportion of size, which is of great moment to the practical optician, the same extent of scale is preserved, and the images are uniformly bright in every part of the field of the telescope.

“ Fig. 4. represents the glasses of a refracting telescope;  $xy$  the principal pencil of rays from the object-glass  $O$ ;  $tt$  and  $uu$ , the axis of two oblique pencils;  $a$ , the first eye-glass;  $m$ , its conjugate focus, or the place of the micrometer;  $b$  the second eye-glass;  $c$  the third; and  $d$  the fourth, or that which is nearest the eye. Let  $\beta$  be the diameter of the object-glass,  $e$  the diameter of a pencil at  $m$ , and  $f$  the diameter of the pencil at the eye; it is evident, that the axis of the pencils from every part of the image will cross each other at the point  $m$ ; and  $e$ , the width of the micrometer-glass, is to  $\beta$  the diameter of the object-glass as  $ma$  is to  $go$ , which is the proportion of the magnifying power at the point  $m$ ; and the error caused by an imperfection in the micrometer-glass placed at  $m$  will be to the error, had the micrometer been at  $O$ , as  $m$  is to  $\beta$ .

“ Fig. 3. represents the micrometer;  $A$ , a convex or concave lens divided into two equal parts by a plane across its centre; one of these semi-lenses is fixed in a frame  $B$ , and the other in the frame  $E$ ; which two frames slide on a plate  $H$ , and are pressed against it by thin plates  $aaa$ : the frames  $B$  and  $E$  are moved in contrary directions by turning the button  $D$ ;  $L$  is a scale of equal parts on the frame  $B$ ; it is numbered from each end towards the middle with  $10$ ,  $20$ , &c. There are two verniers on the frame  $E$ , one at  $M$  and the other at  $N$ , for the convenience of measuring the diameter of a planet, &c. on both sides the zero. The first division on both these verniers coincides at the same time with the two zeros on the scale  $L$ ; and, if the frame is moved towards the right, the relative motion of the two frames is shewn on the scale  $L$  by the vernier  $M$ ; but if the frame  $B$  be moved towards the left, the relative motion is shewn by the vernier  $N$ .

“ This micrometer has a motion round the axis of vision, for the convenience of measuring the diameter of a planet, &c. in any direction, by turning an endless screw  $F$ , and the inclination of the diameter measured with the horizon is shewn on the circle  $g$  by a vernier on the plate  $V$ . The telescope may be adjusted to distinct vision by means of an adjusting screw, which moves the whole eye-tube with the micrometer nearer or farther from the object-glass, as telescopes are generally made; or the same effect may be produced in a better manner, without moving the micrometer, by sliding the part of the eye-tube  $m$  on the part  $n$ , by help of a screw or pinion. The micrometer is made to take off occasionally from the eye-tube, that the telescope may be used without it.”

MICROPUS, BASTARD CUDWEED; a genus of the polygama segregata order, belonging to the fruginea class of plants. There are two species, the su-

pinus and erectus; but only the former is ever cultivated in gardens. It is an annual plant growing naturally in Portugal, in places near the sea. The root sends out several trailing stalks, about six or eight inches long, which are garnished with small, oval, silvery leaves, whose bases embrace the stalks. The flowers comes out in clusters from the wings of the stalks, and are very small, and of a white colour. It flowers in June and July; and is frequently preserved in gardens on account of the beauty of its silvery leaves. It is easily propagated by seed sown in autumn, and requires no other culture but to be kept free from weeds.

MICROSCOPE, an optical instrument, consisting of lenses, or mirrors, by means of which small objects appear larger than they do the naked eye. Single microscopes consist of lenses or mirrors; or if more lenses or mirrors be made use of, they only serve to throw light upon the object, and not contribute to enlarge the image of it. Double microscopes are those in which the image of an object is composed by means of more lenses or mirrors than one. For the principles on which the construction of microscopes depend, and the best methods of making them, see (the *Index* subjoined to) OPTICS.

MICROSCOPIC OBJECTS. All things too minute to be viewed distinctly by the naked eye, are proper objects for the microscope. Whatever object offers itself as the subject of our examination, the size, texture, and nature of it are first to be considered, in order to apply to it such glasses and in such a manner as may shew it best. The first step should always be to view the whole of it together, with such a magnifier as can take it all in at once; and after this the several parts of it may the more fitly be examined, whether remaining on the object or separated from it. The smaller the parts are, the more powerful ought the magnifiers to be which are employed: the transparency or opacity of the object must also be considered, and the glasses employed accordingly suited thereto; for a transparent object will bear a much greater magnifier than one which is opaque, since the nearness that a glass must be placed at, unavoidably darkens an object if in its own nature opaque, and renders it very difficult to be seen, unless by the help of the apparatus contrived for that purpose, which has a silver speculum. Most objects, however, become transparent by being divided into extremely thin parts.

The nature of the object also, whether it be alive or dead, a solid or a fluid, an animal, a vegetable, or a mineral substance, must likewise be considered, and all the circumstances of it attended to, that we may apply it in the most advantageous manner. If it be a living object, care must be taken not to squeeze or injure it, that we may see it in its natural state and full perfection. If it be a fluid, and that too thick, it must be diluted with water; and if too thin, we should let some of its watery parts evaporate. Some substances are fittest for observation when dry, others when moistened; some when fresh, and others after they have been kept some time.

Light is the next thing to be taken care of, for on this the truth of all our observations depends; and a very little observation will shew how very different objects appear in one degree of it to what they do in another;

Microscope; other; so that every new object should be viewed in all degrees of light, from the greatest glare of brightness to perfect obscurity; and that in all positions to each degree, till we hit upon the certain form and figure of it. In many objects it is very difficult to distinguish between a prominence and a depression, a black shadow and a black stain; and in colour, between a bright reflection and whiteness. The eye of a fly in one kind of light appears like a lattice drilled full of holes, in the sun-shine like a solid substance covered with golden nails; in one position like a surface covered with pyramids, in another with cones, and in others with still different shapes.

The degree of light must always be suited to the object. If that be dark, it must be seen in a full and strong light; but if transparent, the light should be proportionably weak; for which reason there is a contrivance both in the single and double microscope to cut off abundance of the rays, when such transparent objects are to be examined by the largest magnifiers. The light of a candle for many objects, and especially for such as are very bright and transparent, and very minute, is preferable to day-light: for others, a serene day-light is best: but sun-shine is the worst light of all; for it is reflected from objects with so much glare, and exhibits such gaudy colours, that nothing can be determined from it with any certainty. This, however, is not to be extended to the solar or camera obscura Microscope; for in that nothing but sun-shine can do, and the brighter that is, the better; but in that way we do not see the object itself on which the sun-shine is cast, but only the image or shadow of it exhibited on a screen; and therefore no confusion can arise from the glaring reflection of the sun's rays from the object to the eye, which is the case in other microscopes. But then in that solar way we must rest contented with viewing the true form and shape of an object, without expecting to find its natural colour; since no shadow can possibly wear the colour of the body it represents.

Most objects require also some management in order to bring them properly before the glasses. If they are flat and transparent, and such as will not be injured by pressure, the best way is to inclose them in sliders between two Muscovy talcs or singllasses. This way the feathers of butterflies, the scales of fishes, and the spring of flowers, may be very conveniently preserved, as also the parts of insects, the whole bodies of minute ones, and a great number of other things. These are to be kept in sliders, each containing three, four, or more holes; and these must not be filled promiscuously; but all the things preserved in one slider should be such as require one and the same magnifying power to view them, that there may not be a necessity of changing the glasses for every object; and the sliders should be marked with the number of the magnifier it is proper to be viewed with. In placing the objects in the sliders, it is always proper to have a small magnifier, of about an inch focus, in your hand, to examine and adjust them by, before they are fixed down with the rings.

Small living objects, such as lice, fleas, bugs, mites, minute spiders, &c. may be placed between these talcs without injuring them, if care be taken to lay on the brass rings without pressing them down, and they will remain alive many weeks in this manner; but if they

Microscope are too large to be treated thus, they should be either preserved between two concave glasses, or else viewed immediately, by holding them in the pliers, or flicking them on the point at the other end of that instrument.

If fluids come under examination, to discover the animalcules in them, a small drop is to be taken with a hair-pencil, or on the nib of a clean pen, and placed on a plate of glass; and if they are too numerous to be thus seen distinctly, some water, warmed by holding it in the mouth, must be added to the drop, and they will then separate and be seen distinctly. This is particularly necessary in viewing the animalcules in the *semen masculinum* of all creatures; which, though extremely minute, are always so numerous, that without this caution their true form can seldom be seen. But if we are to see the salts in a fluid, the contrary method must be observed, and the plate of glass must be held gently over the fire, till part of the liquor is evaporated.

The dissection of minute animals, as lice, fleas, &c. requires patience and care: but it may be done very accurately by means of a needle and a fine lancet, placing the creature in a drop of water; for then the parts will readily unfold themselves, and the stomach, guts, &c. be very distinctly seen.

These seem the best ways of preserving transparent objects; but the opaque ones, such as seeds, woods, &c. require a very different treatment, and are best preserved and viewed in the following manner.

Cut cards into small slips about half an inch long and a tenth of an inch broad; wet these half-way of their length in gum-water, and with that fasten on several parcels of the object; and as the spots of cards are of different colours, such should be chosen for every object as are the most different from its own colours. These are very convenient for viewing by the microscope made for opaque objects with the silvered speculum; but they are proper for any microscope that can view opaque bodies.

A small box should be contrived for these slips, with little shallow holes for the reception of each: and this is conveniently done, by cutting pieces of paste-board, such as the covers of books are made of, to the size of the box, so that they will just go into it; and then cutting holes through them with a small chisel, of the shape of the slips of card: these paste-boards having then a paper pasted over their bottom, are cells very proper for the reception of these slips, which may be taken out by means of a pair of plyers, and will be always ready for use.

Great caution is to be used in forming a judgment on what is seen by the microscope, if the objects are extended, or contracted, by force or drinels. Nothing can be determined about them, without making the proper allowances; and different lights and positions will often shew the same object as very different from itself. There is no advantage in any greater magnifier than such as is capable of shewing the object in view distinctly; and the less the glass magnifies, the more pleasantly the object is always seen.

The colours of objects are very little to be depended on, as seen by the microscope; for their several component particles being by this means removed to great distances from one another, may give reflections

Midas very different from what they would, if seen by the naked eye.

Middleburg The motions of living creatures also, or of the fluids contained in their bodies, are by no means to be hastily judged of, from what we see by the microscope, without due consideration; for as the moving body, and the space wherein it moves, are magnified, the motion must be so too; and therefore that rapidity with which the blood seems to pass through the vessels of small animals must be judged of accordingly; suppose, for instance, that a horse and a mouse move their limbs exactly at the same time, if the horse runs a mile while the mouse runs 50 yards; though the number of steps are the same in both, the motion of the horse must notwithstanding be allowed the swiftest; and the motion of a mite, as viewed by the naked eye, or through the microscope, is perhaps not less different.

MIDAS, in fabulous history, a famous king of Phrygia, who having received Bacchus with great magnificence, that god, out of gratitude, offered to grant him whatever he should ask. Midas desired that every thing he touched should be changed into gold. Bacchus consented; and Midas, with extreme pleasure, every where found the effects of his touch. But he had soon reason to repent of his folly: for wanting to eat and drink, the aliments no sooner entered his mouth, than they were changed into gold; which obliged him to have recourse to Bacchus again, to beseech him to restore him to his former state; on which the god ordered him to bathe in the river Pactolus, which from thence forward had golden sands. Some time after, being chosen judge between Pan and Apollo, he gave another instance of his folly and bad taste, in preferring Pan's music to Apollo's; on which the latter being enraged, gave him a pair of asses ears. See the article APOLLO.

MIDAS, *Ear-shell*, the smooth ovato-oblong buccinum, with an oblong and very narrow mouth. It consists of six volutions, but the lower one alone makes up almost the whole shell.

MID-HEAVEN, the point of the ecliptic that culminates, or in which it cuts the meridian.

MIDDLEBURG, one of the friendly islands in the south-sea. This island was first discovered by Tasman, a Dutch navigator, in January 1742-3; and is called by the natives *Ea-Oo-uhu*: it is about sixteen miles from north to south, and in the widest part about eight miles from east to west. The skirts are chiefly laid out in plantations, the south-west and north-west sides especially. The interior parts are but little cultivated, though very capable of it; but this neglect adds greatly to the beauty of the island; for here are agreeably dispersed groves of cocoa-nuts and other trees, lawns covered with thick grass, here and there plantations and paths leading to every part of the island, in such beautiful disorder, as greatly to enliven the prospect. The hills are low; the air is delightful; but unfortunately water is denied to this charming spot. Yams, with other roots, bananas, and bread-fruits, are the principal articles of food; but the latter appeared to be scarce. Here is the pepper-tree, or *ava-ava*, with which they make an intoxicating liquor, in the same disgusting manner as is practiced in the Society Islands. Here are several odoriferous trees and shrubs, particularly a species of the lemon tribe; and the botanical gentlemen met with

various new species of plants. Here also are a few Middleburg hogs and fowls.

There are no towns or villages; most of the houses are built in plantations, which are laid out in different parts, with no other order than what convenience requires. They are neatly constructed, but are less roomy and convenient than those in the Society Isles. The floors are a little raised, and covered with thick strong mats. The same sort of matting serves to inclose them on the windward side, the others being open. They have little areas before most of them, which are planted round with trees or ornamental shrubs, whose fragrance perfumes the air. Their household furniture consists of a few wooden platters, cocoa-nut shells, and pillows made of wood, and shaped like four-footed stools or forms: their common clothing, with the addition of a mat, serves them for bedding.

The natives are of a clear mahogany or chestnut brown, with black hair, in short frizzled curls, which seems to be burnt at the tips; their beards are cut or shaven. The general stature of the men is equal to our middle size, from five feet three to five ten inches; the proportions of the body are very fine, and the contours of the limbs extremely elegant, though something more muscular than at O-Tahiteite, which may be owing to a greater and more constant exertion of strength in their agriculture and domestic economy. Their features are extremely mild and pleasing; and differ from the O-Tahiteitan faces in being more oblong than round, the nose sharper, and the lips rather thinner. The women are, in general, a few inches shorter than the men, but not so small as the lower class of women at the Society Islands. The practice of puncturing the skin, and blacking it, which is called *tattooing*, is in full force among the men here, for their belly and loins are very strongly marked in configurations more compounded than those at O-Tahiteite. The tenderest parts of the body were not free from these punctures; the application of which, besides being very painful, must be extremely dangerous on glandulous extremities.

The men in general go almost naked, having only a small piece of cloth round the loins, but some wrap it in great abundance round them from their waist; this cloth is manufactured much like that at O-Tahiteite, but overpread with a strong glue, which makes it stiff, and fit to resist the wet. The women are likewise covered from the waist downwards: they often have loose necklaces, consisting of several strings of small shells, seeds, teeth of fishes; and in the middle of all, the round *operculum*, or cover of a shell as large as a crown-piece. The men frequently wear a string round their necks, from which a mother-of-pearl shell hangs down on the breast; both the ears of the women were perforated with two holes, and a cylinder cut out of tortoise-shell or bone was struck through both the holes. The most remarkable circumstance observed of this people was, that most of them wanted the little finger on one, and sometimes on both hands: the difference of sex or age did not exempt them from this amputation; for even among the few children that were seen running about naked, the greater part had already suffered such loss. This circumstance was observed by Tasman. Another singularity which was observed to be very general among these



Middleburg

these people was, a round spot on each cheek-bone, which appeared to have been burnt or blistered. On some it seemed to have been recently made, on others it was covered with scurf, and many had only a slight mark of its former existence: how, or for what purpose it was made, could not be learnt. The women here, in general, were reserved; and turned, with disgust, from the immodest behaviour of ungovernable seamen: there were not, however, wanting some who appeared to be of easy virtue, and invited their lovers with lascivious gestures. The language spoken here is soft, and not unpleasing; and whatever they said was spoken in a kind of singing tone. O-Mai and Mahine, who were both passengers on board the ship, at first declared that the language was totally new, and unintelligible to them; but, however, the affinity of several words being pointed out, they soon caught the particular modification of this dialect, and conversed much better with the natives than any on board the ships could have done, after a long intercourse. They have the neatest ornaments imaginable, consisting of a number of little flat sticks, about five inches long, of a yellow wood like box, firmly and elegantly connected together at the bottom by a tissue of the fibres of cocoa-nut, some of which were of their natural colour, and others dyed black; the same fibres were likewise used in the making of baskets, the taste of which was highly elegant, and varied into different forms and patterns. Their clubs are of a great variety of shapes, and many of them so ponderous as scarce to be managed with one hand. The most common form was quadrangular, so as to make a rhomboid at the broad end, and gradually tapering into a round handle at the other. Far the greater part were curved all over in many chequered patterns, which seemed to have required a long space of time, and incredible patience, to work up; as a sharp stone, or a piece of coral, are the only tools made use of: the whole surface of the plain clubs was highly polished as if an European workman had made them with the best instruments. Besides clubs, they have spears of the same wood, which were sometimes plain sharp-pointed sticks, and sometimes barbed with a sting-ray's tail. They have likewise bows and arrows of a peculiar construction: the bow, which is six feet long, is about the thickness of a little finger, and when slack forms a slight curve; its convex part is channelled with a single deep groove, in which the bow-string is lodged. The arrow is made of reed, near six feet long, and pointed with hard wood: when the bow is to be bent, instead of drawing it so as to increase the natural curvature, they draw it the contrary way, make it perfectly straight, and then form the curve on the other side. Most of their canoes have outriggers, made of poles, and their workmanship is very admirable: two of these canoes are joined together with a surprising exactness, and the whole surface receives a very curious polish. Their paddles have short broad blades, something like those at O-Tahitee, but more neatly wrought, and of better wood.

They keep their dead above ground, after the manner of the Society Islands; as a corpse was seen deposited on a low hut.

Here were seen several men and women afflicted with leprous diseases, in some of whom the disorder

had risen to a high degree of virulence; one man in particular had his back and shoulders covered with a large cancerous ulcer, which was perfectly livid within, and of a bright yellow all round the edges. A woman was likewise unfortunate enough to have her face destroyed by it in the most shocking manner; there was only a hole left in the place of her nose; her cheek was swelled up, and continually oozing out a purulent matter; and her eyes seemed ready to fall out of her head, being bloody and sore: though these were some of the most miserable objects that could possibly be seen, yet they seemed to be quite unconcerned about their misfortunes, and traded as briskly as any of the rest.

MIDDLESEX, a county of England in which stands the city of London. This county, which derives its name from its situation amidst the three kingdoms of the East, West, and South Saxons, is bounded on the west by Buckinghamshire, from which it is separated by the little river Coln and the street ditch; on the north by Hertfordshire; on the east by the river Lea, which parts it from Essex; and on the south by the Thames, which divides it from Surry. It is but of small extent, in length not exceeding 21 miles, in breadth 15, and in circumference eighty; but, by reason of the cities of London and Westminster, and the numerous large villages in their neighbourhood, it is by far the most populous and wealthy in England. The whole of it lies in the diocese of London; and is divided into six hundreds, two liberties, and seventy-three parishes, which, besides London and Westminster, contains five market-towns. There are several royal parks in it, and a great many chapels of ease. The sheriffs are not appointed by the king, but chosen by the liverymen of London.

As the soil is gravelly, and exceedingly well cultivated, in consequence of the great number of inhabitants, the air is very pure and wholesome. The great quantities of rich manure produced by such multitudes of people and cattle has so improved and enriched the lands, that they are extremely fruitful in vegetables of all kinds. In the neighbourhood of London there is little or no corn, the land being employed either for feeding cows, raising hay, or as garden grounds.

MIDDLETON (Dr Conyers), a very celebrated English divine, the son of a clergyman in Yorkshire, was born at Richmond in 1683. He distinguished himself, while fellow of Trinity-college Cambridge, by his controversy with Dr Bentley his master, relating to some mercenary conduct of the latter in that station. He afterwards had a controversy with the whole body of physicians, on the dignity of the medical profession; concerning which he published, *De medicorum apud veteres Romanos degentium conditione dissertatio; qua, contra viros celeberrimos Jacobum Sponium et Richardum Meadum, servilem atque ignobilem eam fuisse, ostenditur*: and in the course of this dispute much resentment and many pamphlets appeared. Hitherto he had stood well with his clerical brethren; but he drew the resentment of the church on him in 1729, by writing "A letter from Rome, shewing an exact conformity between popery and paganism," &c.; as this letter, though politely written, yet attacked popish miracles with a gaiety that appeared dangerous to the cause of miracles in general. Now

Middlesex,  
Middleton

was his Objections to Dr Waterland's manner of vindicating Scripture against Tindal's "Christianity as old as the Creation," looked on in a more favourable point of view. In 1741, came out his great work, "The history of the life of M. Tullius Cicero," 2 vols 4to; which is indeed a fine performance, and will probably be read as long as taste and polite literature subsist among us: the author has nevertheless fallen into the common error of biographers, who often give panegyrics instead of history. In 1748, he published, "A free inquiry into the miraculous powers which are supposed to have subsisted in the Christian church from the earliest ages, through several successive centuries." He was now attacked from all quarters; but before he took any notice of his antagonists, he supplied them with another subject in "An examination of the lord bishop of London's discourses concerning the use and extent of prophecy," &c. Thus Dr Middleton continued to display talents and learning, which were highly esteemed by men of a free turn of mind, but by no means in a method calculated to invite promotion in the clerical line. He was, in 1723, chosen principal librarian of the public library at Cambridge; and if he rose not to dignities in the church, he was in easy circumstances, which permitted him to assert a dignity of mind often forgot in the career of preferment. He died in 1750, at Hildersham in Cambridgeshire, an estate of his own purchasing; and in 1752, all his works, except the life of Cicero, were collected in 4 vols, 4to.

MIDIAN, or *Madian*, (anc. geog.) a town on the south side of Arabia Petræa; so called from one of the sons of Abraham by Keturah. Another Midian, near the Arnon and Æolis, in ruins in Jerome's time; with the daughters of these Midianites the Israelites committed fornication, and were guilty of idolatry. A branch of the Midianites dwelt on the Arabian gulph, and were called *Kenites*; some of whom turned proselytes, and dwelt with the Israelites in the land of Canaan.

MID-LOTHIAN. See LOTHIAN.

MIDSHIP-FRAME, a name given to that timber, or combination of pieces formed into one timber, which determines the extreme breadth of the ship, as well as the figure and dimension of all the inferior timbers.

In the article *SHIP-Building*, the reader will find a full explanation of what is meant by a frame of timbers. He will also perceive the outlines of all the principal frames, with their gradual dimensions, from the midship-frame delineated in the plane of projection annexed to that article. As the parts of which the several frames are composed have the same relation to each other throughout the vessel; and as all the corresponding pieces, without and within those frames, are also nearly alike, and fixed in the same manner; it will be here sufficient for our purpose to represent the principal, or midship-frame, together with its corresponding parts, which are as follow:

A, the keel, with *a* the false keel beneath it.

B, the chocks fixed upon the keelson, to retain the opposite pieces of the *riders* firmly together.

C, one of the beams of the orlop.

D, one of the lower-deck beams; with *d* the beams

of the upper deck.

E, the hanging-knees, by which the beams are attached to the timbers.

F, the standards, which are fixed above the decks to which they belong.

G, the clamps, which sustain the extremities of the beams.

H, the gun-ports of the lower-deck; with *b* the ports of the upper-deck.

I, K, L, several pieces of *thick-stuff*, placed opposite to the several scarfs, or joinings, in the frame of timbers.

M, the planks of the deck.

N, the water-ways.

O, the planks of the ceiling, between the several ranges of thick-stuff.

P, the spiking-wale.

Q, the main-wale, to fortify the ship's side opposite to the lower deck.

R, the channel-wale, opposite to the upper-deck.

S, the waist-rail.

T, the string, with the moulding under the gun-wale.

U, the floor-timbers, which are laid across the keel, and bolted to it.

V, the several futtocks; and W the top-timbers, which are all united into one frame.

X, the keelson.

MIDSHIPMAN, a sort of naval cadet, appointed by the captain of a ship of war, to second the orders of the superior officers, and assist in the necessary business of the vessel, either aboard or ashore.

The number of midshipmen, like that of several other officers, is always in proportion to the size of the ship to which they belong. Thus a first-rate man of war has 24, and the inferior rates a suitable number in proportion. No person can be appointed lieutenant without having previously served two years in the royal navy in this capacity, or in that of *mate*, besides having been at least four years in actual service at sea, either in merchant-ships, or in the royal navy.

Midshipman is accordingly the station in which a young volunteer is trained in the several exercises necessary to attain a sufficient knowledge of the machinery, movements, and military operations of a ship, to qualify him for a sea-officer.

On his first entrance in a ship of war, every midshipman has several disadvantageous circumstances to encounter. These are partly occasioned by the nature of the sea-service; and partly by the mistaken prejudices of people in general respecting naval discipline, and the genius of sailors and their officers. No character, in their opinion, is more excellent than that of the common sailor, whom they generally suppose to be treated with great severity by his officers, drawing a comparison between them not very advantageous to the latter. The midshipman usually comes aboard tintured with these prejudices, especially if his education has been amongst the higher rank of people; and if the officers happen to answer his opinion, he conceives an early disgust to the service, from a very partial and incompetent view of its operations. Blinded by these prepossessions, he is thrown off his guard, and very soon surprised to find, amongst those honest sailors,

sailors, a crew of abandoned miscreants, ripe for any mischief or villainy. Perhaps, after a little observation, many of them will appear to him equally destitute of gratitude, shame, or justice, and only deterred from the commission of any crimes by the terror of severe punishment. He will discover, that the pernicious example of a few of the vilest in a ship of war are too often apt to poison the principles of the greatest number, especially if the reins of discipline are too much relaxed, so as to foster that idleness and dissipation, which engender sloth, diseases, and an utter profligacy of manners. If the midshipman, on many occasions, is obliged to mix with these, particularly in the exercises of extending or reducing the sails in the tops, he ought resolutely to guard against this contagion, with which the morals of his inferiors may be infected. He should, however, avail himself of their knowledge, and acquire their expertness in managing and fixing the sails and rigging, and never suffer himself to be excelled by an inferior. He will probably find a virtue in almost every private sailor, which is entirely unknown to many of his officers: that virtue is emulation, which is not indeed mentioned amongst their qualities by the gentlemen of *terra firma*, by whom their characters are often copiously described with very little judgment. There is hardly a common tar who is not envious of superior skill in his fellows, and jealous on all occasions to be outdone in what he considers as a branch of his duty: Nor is he more afraid of the dreadful consequences of whirling in a storm, than of being stigmatized with the opprobrious epithet of *lubber*. Fortified against this scandal, by a thorough knowledge of his business, the sailor will sometimes sneer in private at the execution of orders which to him appear awkward, improper, or unlike a seaman. Nay, he will perhaps be malicious enough to suppress his own judgment, and, by a punctual obedience to command, execute whatever is to be performed in a manner which he knows to be improper, in order to expose the person commanding to disgrace and ridicule. Little skilled in the method of the schools, he considers the officer who cons his lesson by rote as very ill qualified for his station, because particular situations might render it necessary for the said officer to assist at putting his own orders in practice. An ignorance in this practical knowledge will therefore necessarily be thought an unpardonable deficiency by those who are to follow his directions. Hence the midshipman who associates with these sailors in the tops, till he has acquired a competent skill in the service of extending or reducing the sails, &c. will be often entertained with a number of scurrilous jests, at the expense of his superiors. Hence also he will learn, that a timely application to those exercises can only prevent him from appearing in the same despicable point of view, which must cer-

tainly be a cruel mortification to a man of the smallest sensibility.

If the midshipman is not employed in these services, which are undoubtedly necessary to give him a clearer idea of the different parts of his occupation, a variety of other objects present themselves to his attention. Without presuming to dictate the studies which are most essential to his improvement, we could wish to recommend such as are most suitable to the bent of his inclination. Astronomy, geometry, and mechanics, which are in the first rank of science, are the materials which form the skilful pilot, and the superior mariner. The theory of navigation is entirely derived from the two former, and all the machinery and movements of a ship are founded upon the latter. The action of the wind upon the sails, and the resistance of the water at the stem, naturally dictate an inquiry into the property of solids and fluids: and the state of the ship, floating on the water, seems to direct his application to the study of hydrostatics and the effects of gravity. A proficiency in these branches of science will equally enlarge his views, with regard to the operations of naval war, as directed by the efforts of powder and the knowledge of projectiles. The most effectual method to excite his application to those studies is, perhaps, by looking round the navy, to observe the characters of individuals. By this inquiry, he will probably discover, that the officer, who is eminently skilled in the sciences, will command universal respect and approbation; and that whoever is satisfied with the despicable ambition of shining the hero of an assembly, will be the object of universal contempt. The attention of the former will be engaged in those studies which are highly useful to himself in particular, and to the service in general. The employment of the latter is to acquire those superficial accomplishments that unbend the mind from every useful science, emasculate the judgment, and render the hero infinitely more dextrous at falling into his station in the dance than in the line of battle.

Unless the midshipman has an unconquerable aversion to the acquisition of those qualifications, which are so essential to his improvement, he will very rarely want opportunities of making a progress therein. Every step he advances in those meritorious employments will facilitate his accession to the next in order. If the dunce, who are his officers or mess-mates, are rattling the dice, roaring bad verses, hissing on the flute, or scraping discord from the fiddle, his attention to more noble studies will sweeten the hours of relaxation. He should recollect that no example from fools ought to influence his conduct, or seduce him from that laudable ambition which his honour and advantage are equally concerned to pursue.

## M I D W I F E R Y,

**T**HE art of assisting women in the birth of children. It is supposed to comprehend also the management of women both before and after delivery, as well as the treatment of the child in its most early state.

**HISTORY.** The art of midwifery is certainly almost coeval with mankind. The first midwife of whom mention is made under that name, assisted at the second labour of Rachel, the wife of Jacob. Another midwife is spoken of in Genesis, at the lying-in of Thamar, who was deli-

delivered of twins. But the most honourable mention of midwives is that in Exodus, when Pharaoh king of Egypt, who had a mind to destroy the Hebrews, commanded two midwives to kill all the male children of the Hebrew women; which command they disobeyed, and thereby obtained a recompence from God.

From all the passages in Scripture where midwives are mentioned, it is plain, that women were the only practitioners of this art among the Hebrews. Among the Greeks also women assisted at labours. Phanaerete the mother of Socrates was a midwife. Plato speaks at large of midwives, explains their functions, regulates their duty, and remarks that they had at Athens the right of proposing or making marriages. Hippocrates makes mention of midwives, as well as Aristotle, Galen, and Aëtius. This last even frequently quotes a woman called *Aspasia*, who was probably a midwife. They were called among the Greeks *Μαια*, or *Παιρημαίαι*; that is to say, *matina*, or *grand-mamma*.

We are still better acquainted with the customs of the Romans, and know that they employed women only. This may be deduced from the comedies of Plautus and Terence alone. We there see that they are women only who are called to assist persons in labour. Besides, Pliny, in his Natural History, frequently speaks of midwives and their duties; and names two, *Sotira* and *Salpe*, who had apparently the greatest reputation. Women were also employed after the fall of the empire; and it is certain, that, till lately, all civilized nations have employed women only as midwives. This appears even from their names in many different languages, which are all feminine. There were, however, especially in great cities, surgeons who applied themselves to the art of midwifery, and made it their peculiar study. They were sent for in difficult cases, where the midwives found their incapacity; and then the surgeon endeavoured to deliver the woman by having recourse to instruments useful in those cases, as by crotchets, crows-bills, &c.; but as these cases happened but seldom, women remained in possession of this business. It is certain, according to Astruc, that Maria Theresia wife of Lewis XIV. employed women only in her labours; and the example of the queen determined the conduct of the princesses and court-ladies, and likewise of the other ladies of the city. The same author tells us, that he has been assured, that the epoch of the employment of men-midwives goes no farther back than the first lying-in of Madam de la Valiere in 1663. As the desired it might be kept a profound secret, the sent for Julian Clement a surgeon of reputation. He was conducted with the greatest secrecy into an house where the lady was, with her face covered with a hood; and where it is said the king was concealed in the curtains of the bed. The same surgeon was employed in the subsequent labours of the same lady; and as he was very successful with her, men-midwives afterwards came into repute, and the princesses made use of surgeons on similar occasions; and as soon as this became fashionable, the name of *accoucheur* was invented to signify this class of surgeons. Foreign countries soon adopted the custom, and likewise the name of *accoucheurs*, though they had no such term in their own language;

but in Britain they have more generally been called *men-midwives*.

In opposition to this account, which is taken from Astruc, that author tells us, that he is aware of an objection from Hyginus, who asserts, that the ancients had no midwives; which made the women, through modesty, rather choose to run the risk of death than to make use of men on this occasion. For the Athenians, he adds, had forbid women and slaves to study physic, that is to say, the art of midwifery. A young woman, named *Agnodice*, desirous of learning this art, cut off her hair, dressed herself in the habit of a man, and became a scholar to one Hierophilus. She afterwards followed this business. The women at first refused assistance from her, thinking she was a man; but accepted thereof when she had convinced them that she was a woman.

To this account our author replies, that the authority of Hyginus is by no means to be depended upon. His book is full of solecisms and barbarisms; and therefore cannot be attributed to any writer who lived before the fall of the empire; but must have been the work of an author who lived when the Latin tongue was corrupted; that is, about the seventh or eighth century. The contradictions met with in this book also give room to suspect that it is not the work of one hand, but of several. The authority of such a work, therefore, is by no means sufficient to destroy the testimonies of those writers who affirm, that among the Greeks the care of lying-in women was committed entirely to others of their own sex.

The art of midwifery seems not to have been so soon improved as that of physic. Hippocrates, though an excellent physician, seems to have been a very bad midwife. He was acquainted with no other kind of natural labour than that in which the head presents; and condemns footing labour as fatal both to mother and child: he would have the children in such cases turned, so that the head may present: but, says he, if the arm, or leg, or both, of a living child present, they must, as soon as discovered, be returned into the womb, and the child brought into the passage with its head downwards. For this purpose he advises to roll the woman on the bed to shake her, and make her jump: he proposes the same expedients to procure the child's delivery; and if they do not succeed, he advises to extract it with crotchets, and, whatever happens, to dismember it.

From the time of Hippocrates to that of Celsus, who lived in the reign of the emperor Tiberius, we have no accounts of any improvements in midwifery; but this author gives two very useful directions. 1. In dilating the womb: "We must (says he) introduce the fore-finger, well moistened with hog's lard, into the mouth of the womb, when it begins to open, and in like manner afterwards a second, and so on until all the fingers are introduced, which are then to be used by separating them, as a kind of dilator, to dilate the orifice, and facilitate the introduction of the hand which is to act in the womb. 2. Children may be delivered by the feet easily and safely, without crotchets, by taking hold of their legs. For this purpose we must take care to turn children, which are otherwise placed in the womb, with their head or feet downwards."

*Pregnancy.* wards." It is true, Celsus speaks of a dead child only; but it was easy to conclude from thence, that the same practice might be used with success to deliver a living child. Nevertheless, this was not done; and, notwithstanding the authority of Celsus, the former prejudice continued for a long time. Tho' Pliny, who lived under the emperors Vespasian and Titus, was not a physician himself, yet by condemning footling labour he attests the opinion of the physicians of his time. He asserts, as a known fact, that footling labour was a preternatural kind of labour: he adds, that children which came into the world in this manner were called *Agrippa*, that is to say, born with a great deal of difficulty.

But however common this opinion was, it was never universally received; and several physicians of character rose up, who, without suffering themselves to be dazzled with the common prejudice, or seduced by the authority of Hippocrates or Galen, recommended and approved of footling delivery. The question then was a long time undecided; and even in 1657, Riverius, a physician of reputation, condemned footling labour. Mauriceau also remarks, in the first edition of his book, on the disorders of pregnant women, printed in 1664, that many authors were still of opinion, that when the child presented with its feet, it should be turned to make it come with its head foremost; but after having observed that it is difficult, if not impossible, to execute this, he concludes, "it is much better to extract the child by its feet when they present, than to run the hazard of doing worse by turning it." All practitioners, however, are now of the same opinion; and the knowledge of midwifery has been so much increased within this century, that it seems to have nearly attained its ultimate perfection, and its operations reduced almost to a geometrical certainty: And this, says Astruc, is not surprising; for, after all, the art of midwifery is reduced to the following mechanical problem, "An extensible cavity of a certain capacity being given, to pais a flexible body of a given length and thickness through an opening dilatable to a certain degree." This might be resolved geometrically, if the different degrees of elasticity of the womb, and strength and weakness of the child, the greater or lesser disposition of the blood to inflammation, and the greater or lesser degree of irritability of the nerves, did not occasion that uncertainty which physical facts constantly produce in all physico-mathematical questions.

#### CHAP. I. *Of Pregnancy.*

At the time of conception, and for some time after, the parts which form the small fœtus are so blended together, that one cannot be distinguished from another. The whole mass is then called an *ovum*. This ovum consists of four membranes; the placenta, or after-birth; the funis umbilicalis or navel string, leading to the child; and the surrounding watery fluid in which it floats. Before the child acquires a distinct and regular form, it is called *embryo*, and afterwards retains the name of *fœtus* till its birth. For the increase and nutrition of the fœtus, see the article *GENERATION*.

During the progress of impregnation the uterus suffers considerable changes; but, though it enlarges as

the ovum increases, yet, in regard to its contents, it is never full; for, in early gestation, these are confined to the fundus only: and though the capacity of the uterus increases, yet it is not mechanically stretched, for the thickness of its sides do not diminish; there is a proportional increase of the quantity of fluids, and therefore pretty much the same thickness remains as before impregnation.

The gravid uterus is of different sizes in different women; and must vary according to the bulk of the fœtus and involutera. The situation will also vary according to the increase of its contents and the position of the body. For the first two or three months, the cavity of the fundus is triangular as before impregnation; but as the uterus stretches, it gradually acquires a more rounded form. In general, the uterus never rises directly upwards, but inclines a little obliquely, most commonly to the right side; its position is never, however, so oblique, as to prove the sole cause either of preventing or retarding delivery: its increase of bulk does not seem to arise merely from distention, but to depend on the same cause as the extension of the skin in a growing child. This is proved from some late instances of extra-uterine fœtuses, where the uterus, though there were no contents, was nearly of the same size, from the additional quantity of nourishment transmitted, as if the ovum had been contained within its cavity.

The internal surface, which is generally pretty smooth, except where the placenta adheres, is lined with a tender efflorescence of the uterus, which, after delivery, appears as if torn, and is thrown off with the cleanings. This is the *membrana decidua* of Dr Hunter.

Though the uterus, from the moment of conception, is gradually distended, by which considerable changes are occasioned, it is very difficult to judge of pregnancy from appearances in the early months. For the first three months the os tincæ feels smooth and even, and its orifice as small as in the virgin state. When any difference can be perceived, about the fourth or fifth month from the descent of the fundus through the pelvis, the tubercle or projecting part of the os tincæ will seem larger, longer, and more expanded; but, after this period, it shortens, particularly at its fore-parts and sides, and its orifice or labia begin to separate, so as to have its conical appearance destroyed. The cervix, which in the early months is nearly shut, now begins to stretch and to be distended to the os tincæ; but during the whole term of utero-gestation, the mouth of the uterus is strongly cemented with aropy mucus, which lines it and the cervix, and begins to be discharged on the approach of labour. In the last week, when the cervix uteri is completely distended, the uterine orifice begins to form an elliptical tube, instead of a fissure, or to assume the appearance of a ring on a large globe; and often at this time, especially in pendulous bellies, disappears entirely, so as to be out of the reach of the finger in touching. Hence the os uteri is not in the direction of the axis of the womb, as has generally been supposed.

About the fourth, or between the fourth and fifth month, the fundus uteri begins to rise above the pubes or brim of the pelvis, and its cervix to be distended nearly

nearly one third. In the fifth month the belly swells, like a ball, with the skin tense, the fundus about half way between the pubes and navel, and the neck one half distended. After the sixth month the greatest part of the cervix uteri dilates, so as to make almost one cavity with the fundus. In the seventh month the fundus advances as far as the umbilicus. In the eighth it reaches mid-way between the navel and scrobiculus cordis; and in the ninth to the scrobiculus itself, the neck then being entirely distended, which, with the os tincæ, become the weakest parts of the uterus. Thus at full time the uterus occupies all the umbilical and hypogastric regions; its shape is almost pyriform, that is, more rounded above than below, and having a stricture on that part which is surrounded by the brim of the pelvis.

The appendages of the uterus suffer very little change during pregnancy, except the ligamentâ lata, which diminish in breadth as the uterus enlarges, and at full time are almost entirely obliterated.

The most remarkable change happens in the ovarium. A cicatrice of a roundish figure and yellowish colour appears in this body, called by anatomists the *corpus luteum*. It is always to be found in one of the ovaria, and in cases of twins a *corpus luteum* often appears in both ovaria. It was formerly considered as the calyx ovi; but modern physiologists think it a gland, from whence the seminal fluid is ejected. In early gestation it is most conspicuous, when a cavity is observable, which afterwards collapses; no vessels appear at the centre of this cavity which has the appearance of cicatrix, but all around that centre the substance is vascular.

During the progress of distention, the substance of the uterus becomes much looser, of a softer texture, and more vascular than before conception; its veins particularly, in their diameters, being enlarged in such a manner as to get the name of *sinuses*; they observe a more direct course than the arteries, which run in a serpentine manner, anastomosing with one another and through its whole substance, especially where the placenta adheres, where this vascular appearance is most conspicuous.

The arteries pass from the uterus through the decidua, and open into the substance of the placenta in a slanting direction. The veins also open into the placenta, and by injecting these veins from the uterus with wax, the whole spongy or cellular part of the placenta will be filled.

The muscular structure of the gravid uterus is extremely difficult to be shewn: in the wombs of women who die in labour, or soon after delivery, fibres running in various directions are observable more or less circular, that seem to arise from three distinct origins; viz. from the place where the placenta adheres, and from the aperture or orifice of each of the tubes; but it is almost impossible to demonstrate regular plans of fibres, continued any length without interruption.

#### CHAP. II. Spurious Gravidity.

THE various diseases incident to the uterine system, and other morbid affections of the abdominal viscera, will frequently excite the symptoms and assume the appearance of utero-gestation. Complaints arising

from a simple obstruction, are sometimes mistaken for those of breeding; when a tumour about the region of the uterus is also formed, and gradually becomes more and more bulky, the symptoms it occasions are so strongly marked, and the resemblance to pregnancy so very striking, that the ignorant patient is often deceived, and even the experienced physician imposed on.

Scirrhus, polypous, or sarcomatous tumours in or about the uterus or pelvis; dropsy or ventosity of the uterus or tubes; steatoma or dropsy of the ovaria, and ventral conception, are the common causes of such fallacious appearances. In many of these cases the menses disappear; nausea, retchings, and other symptoms of breeding ensue; flatus in the bowels will be mistaken for the motion of the child; and in the advanced stages of the disease, from the pressure of the swelling on the adjacent parts. Tumesfaction and hardness of the mammæ supervene, and sometimes a viscid or serous fluid distills from the nipple; circumstances that strongly confirm the woman in her opinion, till time, or the dreadful consequences that often ensue, at last convince her of her fatal mistake.

*Falsæ Conception.—Mola.* Other kinds of spurious gravidity, less hazardous in their nature than any of the preceding, may under this head also be classed; diseases commonly known by the names of *falsæ conception* and *mola*: The former of these is nothing more than the dissolution of the fœtus in the early months; the placenta is afterwards retained in the uterus, and from the addition of coagula, or in consequence of disease, is excluded in an indurated or enlarged state; when it remained for months or longer, and came off in the form of a fleshy or scirrhous-like mass, without having any cavity in the centre, it was formerly distinguished by the name of *mola*.

Mere coagula of blood, retained in the uterus after delivery, or after immoderate floodings at any period of life, and squeezed, by the pressure of the uterus, into a fibrous or compact form, constitute another species of mola, that more frequently occurs than any of the former. These, though they may assume the appearances of gravidity, are generally however expelled spontaneously, and are seldom followed with dangerous consequences.

#### CHAP. III. Superfoetation.

SOON after impregnation takes place, the cervix uteri becomes entirely shut up by means of a thick viscid gluten: the internal cavity is also lined by the external membrane of the ovum, which attaches itself to the whole internal surface of the fundus uteri: the fallopian tubes also become flaccid; and are, as gravidity advances, supposed to be removed at such a distance, that they cannot reach the ovaria to receive or convey another ovum into the uterus. For these, and other reasons, the doctrine of *superfoetation* is now pretty generally exploded.—A doctrine that seems to have arisen from the case of a double or triple conception, where, some time after their formation in utero, one fœtus has been expelled, and another has remained; or after the extinction of life at an early period, one or more may be still retained, and thrown

thrown off in a small and putrid state, after the birth of a full-grown child.

The uterus of brutes is divided into different cells; and their ova do not attach themselves to the uterus so early as in the human subject, but are supposed to receive their nourishment for some time by absorption. Hence the os uteri does not close immediately after conception; for a bitch will admit a variety of dogs while she is in season, and will bring forth puppies of these different species: thus it is common for a grey-hound to have, in the same litter, one of the grey-hound kind, a pointer, and a third, or more, different from both; another circumstance that has given rise to *super-satiation* in the human subject, which can only happen when there is a double set of parts, instances of which are very rare.

#### CHAP. IV. *Extra-uterine Fœtuses, or ventral Conception.*

THE impregnated ovum, or rudiments of the fœtus, is not always received from the ovary by the tuba Fallopiana, to be thence conveyed into the cavity of the uterus; for there are instances where the fœtus sometimes remains in the ovary, and sometimes even in the tube; or where it drops out of the ovary, misses the tubes, and falls into the cavity of the abdomen, takes root in the neighbouring parts, and is thereby nourished: But as these fœtuses cannot there receive so much nourishment as in the succulent uterus, they are less, and generally come to their full growth before the common term.

Of these some burst in the abdomen; and others form abscesses, and are thereby discharged; others dry, and appear bony, and remain so during life, or are discharged as above, or by stool, &c.

#### CHAP. V. *Monsters.*

WHEN two or more ova contained in the uterus attach themselves so near one another as to adhere in whole or in part, so as to form only one body with membranes and water in common, this body will form a confused irregular mass called *monstrous*; and thus a monster may be either defective in its organic parts, or be supplied with a supernumerary set of parts derived from another ovum. This seems a rational conjecture; but, while every thing relative to generation is a mystery, how can we account for the extraordinary phenomena? Some authors enumerate a third species of monster, the product of a mixed breed, exemplified, for instance, in the mule, produced by the mixed generation of an ass and a mare. In this animal there are organical parts different from what prevailed in the parents; there is a defect of some parts, a luxuriant growth of others; and the defect in the parts of generation, which renders the animal unfit for propagation, constitutes a very curious and particular species.

#### CHAP. VI. *Diseases of Pregnancy.*

AFTER conception, a remarkable change is soon produced in the general system. This is the source from whence arise different symptoms, that are however liable to considerable variation, not only in the constitution of different women, but in the same wo-

man in different pregnancies, and at different periods of the same pregnancy.

*Pregnancy*,—though a natural alteration of the animal-economy, which every female seems originally formed to undergo, and hence not to be considered as a state of disease, occasions, however, sooner or later, in many women, various complaints, which evidently depend on it as a cause.

Diseases incident to the pregnant state may be considered, either, 1. As arising from sympathy in the early months; or, 2. As depending on the stretching and pressure of the uterus towards the more advanced stages.

1. Though the former of these complaints are generally to be accounted for from other causes than that of plethora; yet, in many constitutions, a certain plethoric disposition in the early months of pregnancy seems to prevail in the vascular system: And therefore, though many inconveniences may ensue from a too frequent, a too copious, or an indiscriminate use of venesection; yet, if prudently and judiciously employed, abortion by this means will not be endangered, as some late authors have alleged; but, on the contrary, on many occasions, a seasonable bleeding will be attended with the most beneficial and salutary effects.

In young women, suddenly affected with severe sickness and loathing, febrile commotion, head-ach, vertigo, and other symptoms of breeding, more especially in full sanguineous habits, besides a spare light diet and suitable exercise, recourse must be had to proper evacuations, the chief of which is venesection: this may be safely performed at any term of gravitation, and occasionally repeated according to the urgency of the symptoms: small breedings, at proper intervals, are preferable to copious evacuations, which in early pregnancy ought always to be carefully guarded against.

When the stomach is loaded with putrid bile or acrid saburra, the offensive matter should be discharged by gentle vomits of ipecacuan, or of infusions of chamomile flowers. The violent efforts to retch and vomit, and the commotions thence excited, which often occasion the expulsion of the fœtus, will by this means frequently be removed, in most cases greatly diminished. During the term of breeding, the state of the belly must be also attended to: When laxative medicines become necessary, those of the mildest and gentlest kind should be administered.

In women liable to nervous complaints, where the stomach is weak, and the sickness violent and continued, the patient should be put on a course of light, aromatic, and strengthening bitters; such as infusions of bark, columbo, &c. and her diet, air, exercise, company, and amusement, should be regulated: In order to settle the stomach, and lessen the sensibility of the system, opiates will often happily succeed, when every other remedy fails.

*Heart-burn and diarrhoea*,—common symptoms of breeding, or of pregnancy, must be treated pretty much as at other times: Both complaints chiefly depend on the state of the stomach.

*Tumescence, tension, and pains in the mammae*.—If tight lacing here be only avoided, and the breasts have room to enlarge and swell, no inconvenience ever

follows: These effects arise from a natural cause, and seldom require medical treatment. If very troublesome and uneasy, bathing with oil, or anointing with pomatum, and covering with soft flannel or fur, will in most cases prove the cure.

*The menstrual evacuation*—is in some women regular for the first, second, or third period after conception. This seldom happens but in women of sanguinary plethoric habits, such as have been accustomed to large copious evacuations at other times, when the discharge is to be considered as beneficial.

*Deliqua, nervous, or hysterical fits*.—When these are occasioned by falls, frights, and passions of the mind, they frequently end in the loss of the child: But when they happen about the term of quickening, they seem to arise from the escape of the uterus from its confinement within the capacity of the pelvis; in which case they are commonly slight, of short duration, and never threaten any dangerous consequence.

II. The second class of complaints, viz. those that are incident to the advanced stages of utero-gestation, and that depend on the change of situation of the gravid uterus, its enlargement and pressure on the neighbouring parts, are more painful in their symptoms, and more dangerous in their consequences, than those enumerated in the preceding class. The premature exclusion of the fetus is generally the worst inconvenience resulting from the one; the death of the mother, along with the loss of the child, is too frequently an attendant of the other.

*Difficulty or suppression of urine*—is sometimes occasioned by the pressure of the uterus on the neck of the bladder, before the fundus uteri escapes from its confinement within the brim of the pelvis. This complaint, if early attended to, will seldom prove troublesome or hazardous; but cannot be entirely removed till the uterus rises above the brim of the pelvis, and by its enlargement becomes supported by resting on the expanded bones of the ossa ilia. But if neglected in the beginning,

*A retroversion of the uterus*—is generally the consequence, a case that demands particular attention. Here the fundus uteri, instead of being loose, falls back in a reclined state within the hollow of the os sacrum: thus a tumor is formed in the vulva, whereof the os tincæ makes the superior part; the body of the uterus, by this means, becomes strongly wedged between the rectum and bladder; and, from the enlargement of the uterus itself, and accumulating load of feces and urine, the reduction will prove in many instances utterly impracticable. A total suppression of urine, or a rupture of the coats of the bladder, fever, inflammation, or gangrene of the uterus, often ensue; and these are succeeded by delirium, convulsions, death.

The indications of cure, in this dangerous disease, are sufficiently obvious: For, in the first place, every obstacle that prevents the reduction should be removed: thus the contents of the rectum and bladder must, if possible, be evacuated; emollient fomentations and cataplasms must be applied, if indicated by inflammation or tumefaction of the parts. Secondly, The reduction of the prolapsed uterus must be attempted, by placing the patient upon her knees, with

her head low and properly supported. While this is attempted within the vagina, a finger or two should also be passed within the rectum, by which the operation in some cases may be facilitated: but, at other times, no power whatever will be sufficient for this purpose. Lastly, If the reduction be accomplished, the fever, inflammatory symptoms, and other consequences of the disease, must be subdued; and a recurrence prevented by an open belly, rest, and recumbent posture, and promoting a free discharge of urine: means that ought to be persisted in till the uterus rises within the abdomen, when the patient will be secured from future danger.

*Costiveness in pregnancy*—is inconvenient. It may proceed from the same cause with the preceding complaint; it may depend of the stomach; the febrile heat, that in many women prevails, will also prove an occasional cause. It may be obviated or prevented by a proper regulation of the regimen, and by such gentle laxative medicines as are best suited to the state of the woman; the chief of which are ripe fruit, magnesia, lenitive electuary, cream of tartar, sulphurous and aloetic medicines, oleum ricini, emollient glysters.

*The piles*—frequently arise in consequence of costiveness, or from pressure of the gravid uterus on the hæmorrhoidal veins. These are also to be removed or palliated by the same means employed on other occasions; regard being had to this distinction, which may be applied universally to the gravid state, that all violent remedies are to be avoided: a light diet should be enjoined; the belly should be kept moderately open; and topical liniments or cataplasms should be applied, such as Bals. sulphur. Bals. traumaticum, Liniment. ex ol. palmæ, Ung. fambucin. com laud. liquid. Poullices of bread and milk with opium, &c. according to the various circumstances of the case.

*Oedematous swellings of the legs and labia*,—are occasioned by the languid state of the circulation, by the interruption of the resistent blood from the pressure of the distended uterus on the vena cava, &c. These, though very troublesome and inconvenient, are seldom however of dangerous consequence, except where the habit is otherwise diseased; and seldom require puncture, as the swelling generally subsides very quickly after delivery. They can only, therefore, at this time, admit of palliation; for which purpose, along with a proper diet and moderate exercise, a frequent recumbent posture, open belly, and dry frictions applied to the legs evening and morning, will prove the most effectual means.

*Varicous swellings in the legs and thighs*—from the interruption of the venal blood in these parts, occasioned by the pressure of the gravid uterus, are to be treated in the same manner with the preceding complaint.

*Pains in the back, loins, cholic-pains, cramps*,—occasioned by the stretching of the uterus and appendages, and from the pressure of the uterus on the neighbouring parts, symptoms that are most troublesome in a first pregnancy, are to be palliated by venesection, an open belly, and light spare diet. If the patient be of a full habit, and pre-disposed to inflammatory complaints, where the pressure is very great in the advanced months, or in twins, &c. if proper



proper remedies are neglected, inflammation of the uterus and adjacent viscera, or dreadful epileptic fits, may quickly ensue; the event whereof is generally fatal. Crampish spasms in the belly and legs require the same palliative treatment; to which may be added friction, and the application of æther, ol. volatil. bals. anodyn. or the like, to the parts affected.

*Cough, dyspœa, vomitings, difficulty or incontinency of urine,* occasioned by the pressure of the bulky uterus on the stomach, liver, diaphragm, &c.—Complaints that can only be alleviated by frequent small bleedings, a light spare diet, and open belly. The patient should be placed in an easy posture, something between sitting and lying; and when the uterus rises high, a moderate degree of pressure from the superior part downwards, may in some cases prove useful. But this must be used with great caution; for dreadful are the effects of violent pressure, or tight lacing, during pregnancy. It frequently kills both mother and child, and ought to be guarded from the earliest months.

*Epileptic fits,*—are a very dreadful and alarming appearance. They generally depend on the same cause with the above complaints: they may also arise from irritation, excited by the motion and stirring of the fœtus; and from various other causes. Such as have had convulsions when young, are most liable to have them during pregnancy: they happen most frequently in first pregnancies, or where the fœtus is very large, or in twins, triplets, &c. In such cases, the distention of the uterine fibres is so great, that actual laceration is sometimes the consequence.

At whatever period of pregnancy they seize, the utmost danger may be dreaded. This, however, will be in proportion to the severity, duration, and recurrence of the paroxysm, to the term of gravitation, to the constitution of the patient, and her condition during the remission. The danger is greater towards the latter end of pregnancy than in the earlier months or in time of labour.

Such as arise from inanition, from excessive and profuse hæmorrhages, from violent blows, falls, &c. or from a ruptured uterus, are for the most part fatal.

Hysterical or nervous spasms must be carefully distinguished from true epileptic fits. The former are milder than the latter; they are not attended with foamings; they do not affect the posture; the pulse is smaller, feebler, and more frequent; the woman is pretty hearty after they are over; they are followed with no bad consequences, and yield to the common treatment. Women of strong, robust, vigorous constitutions, are more generally the subjects of the *one*; the delicate, the nervous, and the irritable, of the *other*.

Epileptic fits generally come on very rapidly; if any previous symptoms occur, the fit is commonly announced by an intense pain in the serobiculum cordis, or violent head-ach.

In the pregnant state, these fits are for the most part symptomatic, and will therefore only admit of a palliative cure. They may be distinguished into three classes; those of the early months, those of the latter, and those that come on with labour-pains.

With regard to the cure, the term of pregnancy,

as well as the constitution of the patient, and particular cause of the disease, must carefully be considered.

1. Convulsions at an early period of pregnancy chiefly happen to young women of a plethoric sanguine habit; and can therefore only be removed or palliated by a free and bold use of the lancet, by an open belly, cool regimen, and spare diet. After plentiful evacuations, if the stomach be loaded with acrid faburra or putrid bile, a gentle puke may be of use: but such remedies, on those occasions, must be employed with great caution. Instead of a plethoric, if the patient is of a nervous habit, a very necessary and important distinction, the intentions of cure will essentially vary. For here opiates in large doses and frequently repeated, emollient glysters, stupes applied to the legs, the femicupium, and every other means to soothe the nerves and remove spasmodic stricture, will prove the most effectual remedies. If insensible or comatous, opium, musk, and other antispasmodics, should be exhibited by way of glyster, and the patient ought to be roused by epispastic and stimulating cataplasms applied to the legs and hams. Convulsions succeeding profuse evacuations, are generally mortal. The vis vitæ, in such circumstances, must be supported, by replenishing the vessels with the utmost speed: this is to be done by pouring in nourishing fluids as fast as possible by the mouth, and by glyster; warm applications should also be made to the stomach and feet, and nervous cordials given internally along with opium.

The treatment of epileptic fits, depending on other causes than those now mentioned, must be regulated by a proper attention to the particular symptoms with which they are attended.

2. In the advanced months, such complaints are more to be dreaded than in early gestation, as they generally proceed from the irritation occasioned by the distention of the uterine fibres, or by the pressure of the uterus on the contiguous viscera: hence the natural functions of these parts will be interrupted, the circulation of their fluids will be impeded, and the blood, being thus prevented from descending to the inferior parts, will be derived in greater proportion to the brain, and overcharge that organ.

The cure must, in this case, chiefly rest on copious and repeated bleedings, an open belly, and spare diet.

3. Lastly, when fits come on with labour-pains, a speedy delivery, if it can be done with safety, either by turning the child, or by extracting with the forceps when the head is within reach, will prove the most effectual cure.

When the bladder is distended, the contents must be evacuated: if a stone sticks in the urethra, it must be pushed back or extracted. If the fits are the effects of a ruptured uterus, immediate death is generally the consequence.

With regard to the treatment of such complaints, no other change is generally requisite, than what arises from the symptoms peculiar to this situation. In general, till after delivery, they will only admit of palliation.

#### CHAP. VII. *Floodings.*

THESE, tho' confined to no particular term, may hap-  
pen

pen at every period of gravitation. The one is a frequent consequence of the other; the event of both is often hazardous, as the earlier miscarriages are generally preceded by an effusion of blood from the uterus, which, in the advanced stages of pregnancy, besides the loss of the child, always endangers the life of the mother.

The *menorrhagia gravidarum*—may be defined, an effusion of blood from the uterus, confined to no regular or stated periods, in quantity and duration various, and liable to recur on the slightest occasions.

The immediate cause is, a separation of some portion of the placenta or chorion from the internal surface of the uterus. Whatever occasions this separation may be considered as the remote cause, which, though various, may be reduced to

- I. Those that affect the general system: as,
  1. External accidents changing the state of the circulation.
  2. Changes in the circulation from internal causes.
  3. Debility.
  4. Plethora.
- II. Those that affect the uterus and placenta: as,
  1. Direct affections.
  2. Stimuli communicated from an affection of other parts.

With regard to the cure.—Though a flooding in some constitutions may happen, even in early gestation, and may remit and recur from time to time, and the woman go on to the end of her reckoning; and tho' it seldom or never happens, that this complaint proves mortal to the mother in the first five months of pregnancy; yet every appearance of this kind, even the slightest, is to be dreaded; as in the early months it will often throw off the fetus, and, in the latter, always threatens the utmost danger both to mother and child. Floodings of gravid women we cannot propose radically to cure; they will only admit of palliation. With this view, the indications are,

I. To lessen the force and velocity of the blood in general.

II. To promote the constriction of the patulous mouths of the bleeding vessels, or the formation of coagula in their orifices.

1. To answer the first indication, rest and a recumbent posture, cool air, tranquillity of mind, a light diet, venesection, and opiates, are the chief means.

2. To restrain the violence of the hæmorrhage, internal astringent medicines are recommended; but this is to be accomplished chiefly by means of cold styptic applications to the parts and their neighbourhood. But, as these floodings often arise from so various and opposite causes, it is difficult to lay down particular indications, or to point out a method of cure suited to every case that may occur. The intention of cure can only be regulated by a careful and judicious consideration of the cause, and of those particular circumstances with which the case may be attended. In early pregnancy, it may be restrained by keeping the patient quiet and cool, by giving internally cooling things and opiates; but, in the advanced stages, the deluge is sometimes so profuse as to kill very suddenly. Under such circumstances, when the woman is near her time, emptying the uterus by delivery, if practicable, is the only safe expedient both for preserving the life of the

mother and of the child.

If the hæmorrhage can be restrained, a recurrence must be guarded against, by avoiding or counteracting the occasional or remote causes.

#### CHAP. VIII. *Abortion, or Miscarriage,*

MAY be defined, the premature expulsion of the embryo or fetus. Some, however, make the following distinction: When a woman miscarries in early gestation, this they consider as an abortion; but if in the latter months, that they term a *premature birth*. The symptoms that threaten abortion are:

Flooding.

Pain in the back and belly.

Bearing down pains with regular intermissions.

The evacuation of the waters.

The death of the child, which discovers itself by the following symptoms; though in general these are so doubtful and fallacious, that none of them afford an infallible sign:

1. The subsiding of the abdominal tumour.
2. Cessation of motion in the fetus.
3. The sensation of a heavy weight falling from side to side, as the woman turns herself in bed.
4. Sickness, faintings, rigors, cold sweats.
5. The breasts turning flaccid.
6. Coldness of the abdomen, and putrid discharge from the vagina.

Abortions are seldom dangerous in the first five months; but a frequent habit of miscarriage debilitates the system, shatters the constitution, and lays the foundation of chronic diseases of the most obdurate and dangerous nature.

In the advanced months, the prognosis will be more or less favourable, according to the patient's former state of health, the occasional cause, and symptoms with which it is attended. The proximate cause of abortion is the same with that of true labour, *viz.* a contracting effort of the uterus and abdominal muscles, assisted by the other expulsive powers. The remote causes cannot be explained with precision; as many circumstances, with regard to the nature of impregnation, and connection of the fetus with the placenta and uterus, are subjects still involved in darkness. They may in general, however, be reduced,

I. To whatever interrupts the regular circulation between the uterus and placenta.

II. To every cause that excites the spasmodic contraction of the uterus, or other assisting powers.

III. To whatever occasions the extinction of life in the fetus.

Amongst the first are:

1. Diseases of the uterus.
2. Imperviousness or spasmodic constriction of the extremities of the uterine blood-vessels.
3. Partial or total separation of the placenta or chorion from the uterus.
4. Determination to other parts.

To the second general head belong all causes that produce a strong contraction of the elastic fibres of the uterus, or of the parts that can press upon it, or that occasion a rupture of the membranes: such as,

1. Violent agitation of mind or body.
2. A disease of the membranes.
3. Too large a quantity of liquor amnii.

Abortion.

4. The cross position of the fœtus.
  5. Its motion and kicking.
- The last head includes the numerous causes of the death of the child, which, besides those referred to in the preceding classes, may be occasioned by,
1. Diseases peculiar to itself.
  2. Diseases communicated by the parents.
  3. External accidents happening to the mother: or,
  4. Accidents incident to the fœtus in utero.
  5. Diseases of placenta or funis.
  6. Knots and circuminvolutions of the chord.
  7. Too weak an adhesion of placenta or chorion to the uterus: and,
  8. Every force that tends to weaken or destroy this attachment.

With regard to the treatment. This must be varied according to the particular circumstances of the case: nor is it possible to point out particular indications, or propose any regular plan to be pursued for this purpose. Abortion is often preceded by no apparent symptom, till the rupture of the membranes, and evacuation of the waters, announce the approaching expulsion of the fœtus. Either to remove threatening symptoms, or to prevent miscarriage when there is reason to apprehend it, often baffles our utmost skill; because it generally happens, that there is a cessation of growth in the ovum; or, in other words, an extinction of life in the fœtus, some time previous to any appearance of abortion. For instance, in early gestation, a woman commonly miscarries about the 11th or 12th week; but the age of the fœtus at this time is generally no more than eight weeks. At other times, when by accident the fœtus perishes, perhaps about the fifth or sixth month, it will still be retained in utero, and the expulsion will not happen till near the completion of full time.

As women who have once aborted are so liable to a recurrence from a like cause, at the same particular period, such an accident, in future pregnancies, should therefore be guarded against with the utmost caution. On the first appearance of threatening symptoms, the patient should be confined to a horizontal posture; her diet should be light and cooling; her mind should be kept as tranquil as possible; a little blood from the arm may be taken occasionally; and opiates administered according to circumstances; but excepting so far as depends on these, and such like precautions, for the most part, in the way of medicine, very little can be done.

Manual assistance is seldom or never necessary during the first five months of pregnancy: the exclusion of fœtus and placenta should very generally be trusted to nature.

The medical treatment of abortion must therefore be considered with a view only to the prophylactic cure: and this again will chiefly consist in a proper

#### CHAP. IX. Regimen during Pregnancy.

WOMEN, when pregnant, should live a regular temperate life; moderation in eating and drinking should now be very carefully observed, and every thing that has any tendency to disagree with the stomach should be avoided; otherwise the manner of life should be much as usual. If complaints do occur, these should be treated as at other times; only guarding against such things

as, by violent operation, may endanger miscarriage. If the woman has formerly been subject to this accident, the cause should be carefully considered, and suitable remedies applied; if plethoric, for instance, she should be bled, live sparingly, and keep quiet, till she gets beyond the dangerous period. If she be weak, delicate, and nervous, bark, light aromatic bitters, mineral waters, and the cold bath (if able to bear it), will prove the best prophylactic remedies. The cold bath has, in many cases, cured the most obstinate fluor albus, and sometimes even sterility itself; and, in relaxed habits disposed to miscarriage, when every other means has failed, the cold bath has done considerable service: the practice may safely be continued for some months after conception, when it has been early begun, or when the patient has been accustomed to it. Such a shock will, however, act very differently on different systems: hence, it is an expedient by no means to be indiscriminately used in the pregnant state.

Abortions that happen in early gestation, and that come on suddenly without any preëling sign, if ever they are to be prevented, it can only be done by avoiding all occasional causes, by counteracting morbid disposition, and by confinement to a horizontal posture, for some time before, and till the critical period be over.

When a venereal taint in the parents is suspected to be the cause either of abortion or the death of the fœtus, the like accident can only be prevented by putting both parties on a mercurial course.

Pregnant women require a free pure air; their amusement should often be varied; their company should be agreeable and cheerful; their exercise should be moderate, and suited to their inclination, constitution, and the season; they should avoid crowds, confinement, travelling over rough roads in a carriage, or being exposed to sea-voyages. Riding a-horseback should also be practised with great caution, that disagreeable objects may be shunned, and shocks of every kind prevented. For this reason, when riding is judged proper, the woman should be a courageous rider; she should never ride without somebody being in company; the horse should be tame and well trained; the road should be smooth as well as private; and the exercise should be gentle and easy, and never carried the length of fatigue. Women should, with the utmost care, guard against confining the breasts or belly; early recourse should be had to jumps, and they should keep themselves as loose and easy as possible through the whole term of utero-gestation. An open belly is necessary and important in the pregnant state; it keeps the stomach in good condition, prevents cholics and other complaints that may terminate in miscarriage. When the abdomen is pendulous towards the latter months, a gentle support by proper bandage will prove useful; and the woman, when fatigued, should occasionally, through the day, indulge in rest on a bed or couch.

#### L A B O U R S.

LABOURS are divided into three classes: *natural*, *labourious*, and *preternatural*.

In whatever manner the head of the child presents, where the delivery at full time is performed by nature, the labour is with great propriety called *natural*; when the

the birth is protracted beyond the usual time, or cannot be accomplished without extraordinary assistance, it is deemed *laborious*; and *preternatural*, when any other part but the head prevails.

#### CHAP. X. *Natural Labour.*

By whatever power the uterus is enlarged, when any further increase is prevented, a stimulus to contraction must ensue; by this means an uneasy sensation is excited, which must, in the woman, produce an effort to procure relief: and thus arise the true labour-pains, which at first are slight and of short duration, a considerable remission intervening: the periods of recurrence soon become more frequent; the pains acquire an increased force, producing more and more change on the os uteri; which, yielding to the impelling cause, gradually opens and expands; till at length it becomes completely dilated, the membranes protruded and ruptured, and the child, by the expulsive force of the uterus, assisted by that of the diaphragm and abdominal muscles, is thus pushed along and delivered.

The symptoms of approaching labour are, The subsiding of the abdominal tumour: hence a discharge of mucus from the vagina, sometimes tinged with blood; incontinency, or suppression of urine; tenesmus; pains of the belly, loins, and about the region of the pubes; restlessness, hot and cold fits, &c.

Spurious pains are to be carefully distinguished from those of genuine labour. The former arise from the stretching of the uterus and its pressure on the neighbouring parts, or from costiveness; and are to be distinguished from the latter by the following symptoms: They are most troublesome towards the evening, increase in the night, and abate through the day; they are more trifling and irregular than true uterine pains; the uterine orifice is not affected; and there is no increased flow of mucus from the parts.

True pains begin about the region of the kidneys, strike forward towards the pubes, and down the thighs: they return at regular periods: there is a copious discharge of mucus from the vagina; the os uteri gradually opens, and can be felt to dilate in time of a pain; while the membranous bag, in a tense state, forcibly pushes against the finger.

The event of labours is so precarious, that no certain judgment can be formed from almost any symptoms, till the labour itself be considerably advanced. A prognosis in general is chiefly to be formed from the age, state of health, and temperament of the patient; from the force, duration, and recurrence of the pains; and from their effect on the uterine orifice; from the time of the rupture of the membranes; from the general make and form of the woman, but, in particular, of that of the pelvis; from the bulk and position of the child, &c.

With regard to the method of delivery, and position of the woman, this has been different at different ages, and in different countries: the chief thing, however, is to guard against cold and fatigue, observing that the woman be placed in the most favourable posture for supporting the back, for the action of the abdominal muscles, &c. and most convenient for the necessary assistants: till the labour is considerably advanced, she may be indulged in whatever posture is most agree-

able; after which the bed or couch is the most proper.

With regard to assistance in natural parturition, the accoucheur for the most part has little to do, till the membranes are ruptured, and the head in perinæo. In time of labour, the woman should be kept very cool, and every means of being overheated should be avoided. She should be put to bed in proper time, placed on her side or back, with her head and shoulders a little raised, a cloth tied to the bed-post, or held by an assistant, to support her hands in time of pain, and her feet resting against a foot-board; her knees should be drawn up towards the belly, and a folded pillow put between them. All efforts to prefs or strain, except what nature excites, are improper, hurtful, and should be avoided: the membranes, if possible, ought not to be ruptured till they almost protrude at the os externum: the perinæum must be lubricated when formed into a tumour, and carefully supported while over-stretched; for this purpose, a cloth smoothly folded should be applied over the part, to enable the accoucheur to have a firmer hold. This is an important part of his office; and must be attended to with the strictest care. From the time this protrusion begins to form till the head of the child be completely delivered, the perinæum must be carefully preserved by the palm of the hand firmly applied against it, which should be carried backwards in a direction towards the anus, and kept so during every pain. Thus the miserable consequences will be prevented to which the neglect of this pressure exposes: for by this support the over-stretching of the perinæum will be greatly lessened, the parts will dilate gently and gradually, the vertex will easily slip from under the pubes, and the fore-head will rise from under the perinæum in a safe, slow, and gentle manner. The perinæum must now be released, by cautiously sliding it over the face and chin of the child; and this ought to be made further sure of, by passing a finger under it round and round. After the head has thus mechanically advanced through the pelvis and vagina, a pain or two must be waited for, when in like manner the body will follow; nothing more being necessary than to support the child while it is gradually pushed forwards by the expulsive force of the natural pains.

When the child has cried, and the change in the circulation freely taken place, the funis umbilicalis must be tied and divided, the infant must be wrapped in a warm receiver, and given to the nurse to be washed and dressed.

The parts of the woman must now be gently wiped, a warm soft cloth must be applied, and a proper time waited for the separation of the placenta.

This is also the work of nature, and seldom requires more force to bring it along than if it lay entirely loose within the cavity of the uterus. Thus, in pulling, no greater force should be employed than is just sufficient to put the funis on the stretch: for if it is already separated, no violence is necessary to extract it; and if the adhesion is very firm, all violent efforts are improper, and often followed with most dangerous consequences. Its advancing is known by the contraction of the uterus, and shifting of the abdominal tumour, and by the lengthening of the cord. By the spontaneous contraction of the uterus, this separation is effected; the expulsion will be slower or more expeditious,

ditious, according to the state and condition of the woman, according to the number of children she has born, and according to the duration or violence of the labour; it is earlier and sooner separated in a first birth, when the woman is in good health, and when the labour has been properly managed. In most cases, this separation is accomplished within half an hour after the delivery of the child. It adheres most firmly after premature births, when the woman has been sickly during pregnancy, where the labour has been tedious and difficult, or when hasty attempts have been made to extract it. A finger, or finger and thumb, guided by the funis, and introduced within the vagina, to bring down the edge, will remove any difficulty occasioned by the centre or bulky part passing the uterine or vaginal orifice.

When it becomes necessary to employ force in extracting the placenta, which is never requisite but in cases of flooding, when the woman has been in bad health during pregnancy, when she has suffered much in time of labour, or when the string has been torn from it, (though the first of these cases is perhaps the only one wherein the practice is absolutely proper), the method of doing it is as follows: In ordinary cases, the woman should be laid on her back or side; but when the belly is pendulous, or when the placenta is attached to the fundus uteri, she must be placed on her knees, which is the most convenient posture.

The accoucheur, though with a certain degree of courage, yet with the utmost possible tenderness, must then pass his hand well lubricated through the vagina into the uterus, and feel for the convex body of the after-birth; if the chord be entire, this will direct him; if not, he must feel for the loose membranes at the edge of the cake; and must not be deceived by coagula of blood that lie in the way: if the uterus be constricted in the middle like a sand-glass, a circumstance that sometimes, though rarely, occurs, this must be overcome by a gradual dilatation with one finger after another, till the whole hand in a conical manner can safely be passed. He must not content himself with feeling a part; he should be able to move his fingers round the whole body of the cake; the adhesion must be separated very gradually, in a direction from the sides round and round. The placenta is distinguished from the uterus, as well by its softness as by its convex puckered feel. This convexity increases in the same proportion as the uterus contracts: hence the middle part or centre of the placenta is first detached; and if the edges are carefully separated, by gently passing the fingers behind, the whole body becomes loose and disengaged, which must now be brought along with great caution, that no part be left behind, and that no injury be done to the woman in making the extraction.

Though bad consequences sometimes follow from the retention of the placenta, yet it is much to be questioned, if there are not less to be dreaded than the dangerous floodings, convulsions, deliqua, inflammation of the uterus, fever, &c. that may be induced from the preposterous practice of passing the hand to make the extraction: and would it not in general be better to confine the practice of introducing the hand, to cases of uterine hæmorrhages only? Where the adhesion is so firm as to require force, or where its place

of attachment is out of the reach of the finger, by which, for the most part, the edge may be brought down, is it not by far the safest and the most rational practice universally to trust to nature? Should the mouth or body of the uterus become constricted before the separation is effected, no matter; little is to be dreaded: it will afterwards kindly dilate; and the separation and expulsion will spontaneously be accomplished with as much safety as in other animals, where no force is ever used. Let every candid practitioner acknowledge, that for one instance where the retention of the placenta has been attended with dangerous consequences, a precipitate or forcible extraction has proved fatal to hundreds.

After the delivery of child and placenta, the woman must rest a few minutes; her strength and spirits may be recruited by some light nourishing cordial; the wet cloths, &c. must then be removed; the bed must be properly shifted and adjusted; and a gentle compression must be made on the abdomen.

During lying-in, the woman should avoid company and noise; her dress and bed-linens should be often changed; she should avoid every means of being overheated; and with regard to her diet, it should, for the first week at least, be very light and of easy digestion.

#### CHAP. XI. *Laborious or difficult labour.*

WHEN the birth is protracted beyond the ordinary time, or when the child's head, though naturally presenting, cannot be brought forwards without assistance, the labour is accounted difficult or laborious.

Though the causes of laborious births are various and complicated, they may in general be considered as depending,

I. On the mother.

II. On the child.

III. On the secundines.

I. The birth may be protracted, or the labour-pains interrupted, by,

(1.) Debility in the mother, arising,

a From disease, viz.

1. Flooding.
2. Epileptic fits.
3. Crampish spasms.
4. Lowness and faintness.
5. Inflammatory diathesis.
6. Colic.
7. Nauseating sickness and vomiting.
8. Hætic or consumptive habit.

b From passions of the mind.

c From mismanagement in time of labour.

(2.) Local complaints in the parts, or their neighbourhood, viz.

a In the bones, occasioning narrowness and distortion.

b In the soft parts, viz.

1. Dryness and constriction of the vagina.
2. Thickness and rigidity of the os tincæ.
3. Scirrhous or polypous tumours about these parts.
4. Accumulated feces in the intestines.
5. Stone in the urethra.
6. Prolapfus of the uterus, vagina, and rectum.

7. Obliquity of the uterus.
- II. Difficulties also arise on the part of the child,  
*viz.*
1. From the bulk and ossification of the head.
  2. The situation in which the head presents.
  3. Large broad shoulders, or their transverse descent through the pelvis.

- III. The secundines, *viz.*
1. The rigidity of the membranes, and the contrary.
  2. Too great a quantity of water.
  3. The funis umbilicalis too long, or too short.
  4. The prolapsus of the funis before the child's head: and,
  5. The attachment of the placenta towards the cervix or os uteri.

The treatment of laborious births requires a very nice and careful attention to the condition of the patient and other circumstances, from whence only we can judge when assistance becomes requisite, and how it may be applied to the best advantage. That pain and misery is the unavoidable and inseparable attendant of child-bearing, though dealt out in different proportions to different subjects, the testimony of all nations, and all ages, as well as daily experience, bear witness: nor is the easiest labour altogether exempted from pain, even under the most favourable circumstances. The delivery, however, promises to be safe and easy, when the woman is of proper age, in good health, the child presenting right, and the pelvis well proportioned: but the force of the natural pains may be interrupted, and of consequence labour be retarded, from,

- I. Debility in the mother, arising from  
a Disease. This may appear under various forms;  
as,

1st, A flooding. Which is very alarming, even along with labour-pains: though less so in this case than when at a distance from full time; because as the labour-pains increase, the hæmorrhage very generally abates; or if not, breaking the membranes when the aperture of the os uteri is sufficient to admit the hand, seldom fails to produce that effect. The woman in this case must be kept cool. Opiates must be administered; she must be comforted with the best assurances of a happy delivery; and the natural pains must be waited for.

But if the hæmorrhage proceeds from a separation of the placenta, attached towards the cervix or os uteri; in this unhappy case, the whole body of the cake may be completely separated before the aperture of the uterus be sufficient for allowing the head to pass; and the deluge may be so sudden and impetuous, that the woman will sink immediately under it. Breaking the membranes, and making the delivery, either by turning the child, or extracting with the forceps or crotchet, according to circumstances, with as much expedition as is consistent with the mother's safety, is the only expedient by which the threatening catastrophe may be prevented.

2dly, Epileptic fits may in like manner retard labour, and endanger the life of the mother. If the child is not thrown off by a few fits, which is often the case, the delivery should be effected as soon as possible.

3dly, Crampish spains in the thighs, legs, rarely in the belly, are very troublesome. They depend on the pressure of the head on the nerves as it passes through the pelvis, and can only be removed by delivery, which, as these pains are seldom, if ever, attended with danger, is not to be forced on this account. Breaking the membranes will sometimes remove them.

4thly, Lowness and faintnesses often occur, and frequently prove the cause of protracted labour.

No general rules with regard to the management of slow labour can be recommended. The mode of treatment, where so many circumstances may occur, must be suited to the condition of the patient, as every particular case will in some measure require a different management. Much depends on the prudence and judgment of the attentive practitioner. For instance, when the woman is nervous, low-spirited, or weakly, from whatever cause, in general her strength must be supported: she must not be put on labour too early: she must avoid heat, fatigue, and every means of exhausting her strength or spirits. When she is restless, or the pains trilling and unprofitable, opiates are particularly indicated; they remove spurious or grinding pains, recruit the spirits, procure rest, and amuse time. Little else for the most part is to be done. If the uterus once begins to dilate, though the dilatation goes on slowly, it is by much the best and safest practice to do nothing but regulate the management as above. The pains at last will become strong and forcing; and the delivery, even where the patient has been very weakly, will often have a safe and happy termination. In these tedious labours, if the strength of the woman be properly supported, every thing almost is to be expected from nature. Forceful means should be the last resource.

5thly, Inflammatory diathesis, in young subjects of strong rigid fibres and plethoric habits, must be obviated by venesection, an open belly, and cooling regimen.

6thly, Colic.—Many women have severe attacks of this disease immediately before the labour-pains come on; the reason of which is sufficiently obvious: the belly, which formerly rose so high, that the fundus of the womb pressed against the pit of the stomach, afterwards subsiding, by the child's sinking to the lower part of the womb, and the oval of the head being applied to the oval of the basin, the contents of the intestines will be forced lower and lower, and the strait gut will be distended. Hence colic-pains, irritation, and uneasiness, a frequent desire to go to stool, or frequent loose stools, generally ensue. The best palliative remedy is to inject emollient glysters repeatedly till the bowels be entirely emptied. Although some degree of purging should attend the tenesmus, it will be necessary to wash the strait gut, by the use of one or more glysters. The irritating cause being in this way removed, an opiate, if no inflammatory heat or fever prevents, may be afterwards given with advantage.

7thly, Nauseating sickness, with vomiting.—When these symptoms occur, warm water or chamomile-tea must be drunk freely. Sicknes and vomiting happen in some degree in the easiest labours. Sometimes they proceed from a disordered state of the stomach; but in general are to be accounted for from the well-

known sympathy of the womb with the stomach; and accompany the stretching of the os uteri only.

8thly, Hætic or consumptive habit.—It is a melancholy thing to attend a labouring woman in this state. The pains are weak and trifling; she cannot force much down; and she is feeble, and liable to faint when the pain goes off. But however apparently exhausted, the progress of labour goes on, in most cases, much better than could be well expected. The orifice of the womb gives little resistance to the force of the pains, weak and trifling as they are; and the parts are soft and lax, and soon stretch in such a manner, that, if there be no fault in the pelvis, the child readily obtains a passage.

Here little is to be done, but supplying the patient, from time to time, with light nourishment; with cordials that do not heat; and keeping up a free circulation of cool air all around her: for this purpose the curtains should be quite drawn aside, doors and windows widely opened; and she should be placed in a position with her head and breast well raised, that an easy respiration may be promoted. Hætic women under proper management rarely sink immediately after delivery; they generally survive a week, or longer, tho' they seldom outlive the month.

b. Passions of the mind. Any piece of news in which the patient, her family or relations, are interested, should be carefully concealed, as well as every thing that tends in general to affect the passions; as labour may not only be interrupted from this cause, but the most dangerous symptoms, as floodings, convulsions, deliquia, and fatal syncope, may be induced.

c. From mismanagement in time of labour often arises debility; so that the patient's strength is exhausted, the pains at length entirely cease, and the head of the child remains locked in the pelvis, merely from want of force of pain to push it forwards. In all cases where the labour has the appearance of being tedious, the woman's patience must, as much as possible, be supported. During the grinding pains, she must be kept cool and quiet; opiates may be exhibited to pass the time, till the forcing throes ensue, when she will acquire resolution, the parts will dilate kindly, and the labour end happily; whereas, if she considers herself in labour from the earliest appearance of grinding pains, she is frightened at the length of time, and her patience runs out. Slow lingering labours happen chiefly to elderly women having a rigidity in the parts, to nervous subjects, and to such as have been weakly during pregnancy. It is of great consequence, and the advice cannot be too much inculcated, to avoid exhausting the woman's strength too much at first.

2. *Local complaints in the parts, or their neighbourhood.*

a. *Narrowness or distortion of the bones of the pelvis.* Where there is any material defect in this cavity, a superficial knowledge of the form and structure of the parts will enable us to judge. If, from the figure of the woman's body, there is reason to suspect a faulty pelvis; if the spine is twisted, the legs crooked, the breast-bone raised, or the chest narrow; whether the pelvis be affected or not, she will require a particular management; for the constitution of such women is weak and feeble, and they cannot be much confined to bed on account of their breathing. We can never be

absolutely certain of a distortion of the pelvis, (except when the distortion is confined to the inferior aperture), till the uterine orifice is considerably dilated. After this time, if the pains are strong and forcible, and the head of the child makes no advance, a narrow pelvis or large head is to be suspected. The pelvis may be faulty at the brim, bottom, or in the cavity or capacity. The first of these, which most frequently occurs, is the most difficult to be discovered. The second can be readily perceived by the touch: for we can feel the defects in the shape of the os sacrum and coccyx, in the position of the ischia, and in the bending of the pubes; and where the distortion is so general, that the whole cavity of the pelvis is affected, the shape of the woman's body, the slow progress of the labour, and the state of the parts to the touch, will afford sufficient information.

In the first case, we can only know the distortion by the symptoms; for we should not attempt to introduce the hand till the mouth of the womb be dilated: it is afterwards unnecessary; for we know that the pelvis is too small, or the head too large, by its not advancing in proportion to the pains, and by feeling a sharp ridge like a sow's back on the top of the child's head, which is occasioned by the bones rising over each other in consequence of the pressure.

How long nature, in such circumstances, can support the conflict, it is difficult to say. It is sufficient to observe, that when things are properly prepared for the advance of the child, when the first stage of the labour is accomplished, but its progress is then suspended, it is of little consequence to the midwife whether the obstacle is to be referred to the child, or to the mother; and a man-midwife ought to be immediately called in.

If the patient's strength declines; if the head, from being locked in the bones of the pelvis, begins to swell, and the parts of the woman to be affected with tumefaction and inflammation; nature, in this case, seems insufficient, and it will be dangerous longer to delay the proper means of making the delivery; as mother, or child, or both, may fall a victim to our neglect. We must not, however, allow ourselves to be imposed on, either by the impatience of the distressed mother, or by the clamours of the officious impertinents about her. In affording that assistance we are able to give, we are only to be directed by the symptoms of the case: we must remember that the gentlest assistance our hands or instruments in laborious births can afford, is always attended with hazard and risk; that if instruments be applied too early, nature will be thus interrupted in her work, and the most fatal consequences may ensue; and that if assistance be delayed too long, the mother may die undelivered: we ought, however, to be informed, that the former practice of having too early recourse to forcible means, where, in time, nature unassisted might do her business, has proved by far more fatal than the latter. We ought therefore carefully to consider the general history of the patient, and particular circumstances of the case, that we may hit the proper time of making the delivery; which, in these laborious labours, is exceedingly difficult to determine; yet is a matter of the utmost importance, as there is always one, often two or more lives at stake, and the accoucheur is accountable for the consequences of his

misconduct or neglect.

6. The fault may be in the soft parts: as,  
1. Dryness and constriction of the vagina. Here all stretching and scooping is to be avoided. The natural moisture is to be supplied by lubricating with pomatum or butter, or by throwing up injections of warm oil; the parts are likewise to be relaxed by the application of warm flupes, or by warm steams directed to them.

2. Thickness and rigidity of the os tince. This happens chiefly in women well advanced in life, where the parts open more slowly, and the labour generally proves more tedious. Here also little is to be done but waiting on with patience, comforting the woman as well as possible, and giving an opiate from time to time. The parts may be relaxed with butter or pomatum, by throwing into the vagina injections of warm oil, or by the application of warm flupes to the os externum. Every forcible attempt to open or stretch the uterus, as some authors presume to advise, is apt to induce inflammation and its consequences, and to interrupt the natural pains: it is therefore universally the safest practice to trust in every case to these; tho' tedious, or even violent, the labour for the most part will end more happily, and the woman recover better, than if force had been employed.

3. Polypous tumours, &c.—These is seldom occasion, in case of cicatrices in the vagina, to dilate with the scalpel, to remove polypous tumors by excision, or to cut upon and extract a stone from the urethra in time of labour. But, if circumstances are urgent, such expedients are safe and practicable, and warranted by many precedents.

4. Accumulated feces in the intestines, ought always to be removed by repeated emollient glysters, on the first appearance of approaching labour.

5. A stone in the urethra, if it cannot be pushed back, must be cut upon and extracted, as already advised.

6. Prolapsus of the uterus may happen even at full time, in a pelvis too wide in all its dimensions; for which, however, nothing can be done, but to support the uterus in time of a pain, that the stretching of the parts may be gradual. Prolapsi of the vagina and rectum must be reduced at the remission of the pain, and a return by gentle pressure must be prevented.

7. Obliquity of the uterus, though a favourite theory of some authors, never happens in such a degree as to influence delivery, except in the case of a pendulous abdomen, or where it depends on the make or distortion of the pelvis. The first of these, tho' it may, by throwing the child's head over the pubes, occasion perhaps some little delay, will seldom prove any material obstacle to the progress of the labour.

II. The protraction of labour may depend on the child, and may arise from,

1st, The bulk or ossification of the head.

There may be either a natural disproportion between the head and body, or the swelling may be occasioned by a putrid emphysema in consequence of the child's death, or the enlargement may proceed from a hydrocephalus. The first of these cases can only be discovered by the slow progress of the labour, when the pains are strong and frequent, the soft parts sufficiently dilated, the woman in good health, and no

other apparent cause to account for the remora. The second is discovered from the history of the case, from the common symptoms of a dead child, viz. the puffy emphysematous feel of the presenting part of the head, and from the separation of the cuticle when touched. Lastly, the hydrocephalus is discovered by the head falling down in the pelvis in a large bulky form, by the bones of the head being separated at considerable distances, and by a fluctuation evident to the touch. On the whole, however, it may here be observed, that the most probable or suspicious symptoms of the child's death are often deceitful.

From whatever cause the head is enlarged, if the difficulty arises from this cause, and the force of the pains prove insufficient to push the head forwards, recourse must be had to instruments; and, if the bulk of the head is too large to pass the diameter of the pelvis, the cranium must be opened to diminish its size, and the brain evacuated previous to the extraction.

2dly, The position of the head, which may be squeezed into the pelvis in such a manner as not to admit of that compression necessary for its passing. Such a cause of difficulty, however, more seldom occurs than many authors have imagined. The rash and preposterous application of instruments has, in such cases, proved the bane of thousands. Here though the labour will prove more painful and more tedious, yet nature in general, unassisted, will accomplish her own work with more safety to mother and child, than by the intrusion of officious hands. Turning here is always difficult, often dangerous. The same observation will hold of instruments, which should never be employed but when alarming symptoms occur: the assertion perhaps is not more bold than true, that, in general, the most disadvantageous position in which the head can offer is not sufficient, without some other cause concurring, either to prevent delivery, or to endanger the life of mother or child so much as would be done by the movement of the gentlest hands. Yet, in some cases, where the woman is weak and exhausted, and the pains trifling; if the head of the child be large, the bones firm, and the sutures closely connected; or if there by any degree of narrowness in the pelvis, a difficult labour is to be expected; and the life of both mother and child will depend on a well-timed and skilful application of the surgeon's hands.

The unfavourable position of the head may be referred to two kinds, which include a considerable variety. 1. When the fontanella, or open of the head, presents instead of the vertex. 2. Face-cases.

If no other obstacle appears but the presenting of the fontanella, the labour will, by proper management, generally end well; and much injury may be done by the intrusion of officious hands.

Face-cases are the most difficult and laborious of all kinds of births; and our success in these will chiefly depend upon a prudent management, by carefully supporting the strength of the woman. The varieties of face-cases are known by the direction of the chin; for the face may present, 1. With the chin to the pubes. 2. To the sacrum. 3. To either side. The rule in all these cases is to allow the labour to go on till the face be protruded as far down as possible. It is often as difficult and hazardous to push back the child, and to bring down the crown or vertex, as to turn the child.



child, and deliver it by the feet. Sometimes a skilful artift may fucceed in his attempt to alter the pofition, when he has the management of the delivery from the beginning; or, in thofe cafes where the face is confiderably advanced in the pelvis, may be able to give affiftance by paffing a finger or two in the child's mouth, and pulling down the jaw; which leffens the bulk of the head; or, by preffing on the chin, to bring it under the arch of the pubes; when the crown getting into the hollow of the os facrum, the head will afterwards pafs eafily.

3dly, The breadth of the foulders, or their tranfverfe defcent through the pelvis, rarely proves the caufe of protracted labour. The head is always pretty far advanced before any obftruction can arife from this caufe; and if the head has already paffed, in a pain or two the foulders will follow. The fame reasoning will alfo apply with regard to the aperture of the uterus itfelf: if the head paffes freely, in like manner will the foulders; the os uteri rarely, if ever, is capable of contracting upon the neck of the child, and thus preventing the advance of the foulders; and, fhou'd this prove the caufe, what can we do but wait with patience? After the delivery of the head, if the woman falls into deliqua, or if, after feveral pains, the foulders do not follow, and the child's life be in danger from delay, we fhou'd naturally be induced to help it forward in the gentleft manner we are able, by paffing a finger on each fide as far as the axilla, and thus gradually pulling along.

III. Laftly, From the fecundines, difficulty and danger fometimes arife.

1st, The rigidity of the membranes, and the contrary. From the firft of thefe caufes, the birth is fometimes rendered tedious; but as the fame effect is much oftener produced by the oppofite caufe, and the confequences of the latter are more troublefome and dangerous than the former, we fhou'd always be exceedingly cautious of having recourfe to the common expedient of breaking the membranes, which ought never to be done, till we be certain the difficulty depends upon this caufe; and, even then, the head of the child fhou'd be well advanced, and the membranes protruded almoft as far as the os externum. Many inconveniencies arife from a premature evacuation of the waters; for thus the parts become dry and rigid, a conftriction of the os uteri for a time enfues, the pains often either remit or become lefs ftrong and forcing, though not lefs painful and fatiguing; the dilatation goes on fo flow, and the labour becomes fo fevere, that the woman's ftrength and fpirits, by the unprofitable labour, are quite overcome and exhaufted; fo that the head remains confined in the paffage, merely from want of force of pain to push it forwards. The woman in the beginning of labour fhou'd therefore be treated with the utmoft delicacy and gentlenefs. The work of nature is too often fpoiled by officious hands. She fhou'd be feldom touched while the membranes are whole, leff they fhou'd be ruptured; and, even when touching is neceffary, this fhou'd only be done when the pains begin to remit, and the tenfe membranous bag to relax.

2dly, Too great a quantity of water may prevent the uterus from contracting, and thus weaken the force of the pains. Though this may, however, occafion a

delay, it will never be attended with more dangerous confequences; and the fame advice already given will hold equally good in this cafe, that the membranes fhou'd never be broken till the foft parts be completely dilated; and we are affured that the difficulty or delay proceeds only from this caufe.

3dly, The funis umbilicalis too long. The funis may be faulty from its too great length, or the contrary: thus the extraordinary length, by forming circumvolutions round the child's neck or body, fometimes proves the caufe of protracting the labour. But as this can only happen when the chord is of an uncommon length, there is generally enough left to admit of the exit of the child with fafety; and it is time enough, in general, after the child is born, to flip the noofe over the foulders or head: this is feldom occafion to divide the chord in the birth, a practice that may be attended with trouble and hazard.

The practice of introducing a finger in ano, to prefs back the coccyx, or to prevent the head, when it advances, from being retracted by circumvolutions of the chord, is now entirely laid afide; an expedient that can anfwer no end, but that of fretting and bruifing the parts of the mother, and injuring thofe of the child.

Funis too fhort. The funis is fometimes thick and knotty, or preternaturally thickened by difeafe. In this cafe, part of the placenta may be feparated as the child advances through the pelvis, and thus a flooding will enfue; or the funis may be actually ruptured and occafion the death of the child, if the birth does not quickly follow. Such cafes, however, rarely happen.

An inconvenience, at leaft fully as bad as the former, may arife from the too great length of the funis, though it may depend on other circumftances: *viz.*

4thly, The prolapsus of the funis before the head. In this cafe, the funis, if poffible, fhou'd be pushed up above the prefenting part; for, if the labour pains are flow, and the chord becomes cold, or the pulfation in it begins to grow languid, the circulation will thus be interrupted, and the life of the child destroyed. If the head is far advanced in the pelvis, and the child's life in danger, the delivery may be performed with the forceps. But to push up the head, and turn the child with a view to preferve its life, as many authors recommend, is a practice by no means advifeable: we fhou'd feldom, in this pofition, be enabled to fave the child; and turning under fuch circumftances can never be done, but at the immediate hazard of lofing the mother.

5thly, Placenta attached towards the cervix or os uteri. This cafe is truly melancholy; for, if the delivery is not fpeedily accomplished, the effufion from the uterine veffels will be fo copious and profufe, that the unfortunate woman muft, in a very fhort time, perifh. On this occafion the delivery muft be conducted in the beft manner the judgment and fkill of the operator can direct, and with as much expedition as the fafety of the mother will admit.

Thus, in moft laborious cafes, provided the woman's ftrength be fupported, the management properly regulated, the natural moiſture of the parts when deficient fupplied, manual affiftance very feldom be-

comes requisite: but as cases do occur, wherein nature, with all advantages, will fail, and the common methods of relief prove unsuccessful, recourse must be had to more powerful means, while the woman is able to support the conflict. In all such cases, the condition of the patient, the structure and state of the parts, and position of the presenting part of the child, must very carefully be considered.

#### *Method of Delivery by Instruments.*

WHEN the powers of nature are insufficient to expel the child, extraordinary assistance must be had recourse to. In laborious births, this is chiefly of two kinds.

- I. The head is either extracted as it presents; or,
- II. Its diameter is diminished previous to the extraction.

The head may be detained from advancing thro' the pelvis by all the causes formerly enumerated. These are chiefly included in four general ones,

1. Weakness in the mother.
2. Narrowness of the pelvis.
3. The bulk of the head of the child: or,
4. Its disadvantageous position.

Whatever is the cause, when the natural pains begin to remit, and the parts of the woman begin to swell; when her strength declines, her pulse grows feeble, and there is no prospect of advantage to be gained by delay; measures must be taken for assisting the delivery, otherwise both mother and child may perish from neglect.

As instruments are never to be employed but in the most urgent and necessitous cases, and expressly with a view to preserve the life of mother or child, or both; those of a safe and harmless kind should always be made trial of, in preference to those of a destructive nature.

#### *Use of the Forceps.*

THE forceps, is an instrument intended to lay hold of the head of the child in laborious births, and to extract it as it presents. This instrument, as now improved, in the hands of a prudent and cautious operator, may be employed without doing the least injury either to mother or child.

In every obstetrical case, wherein manual assistance becomes necessary, the contents of rectum and bladder should, if possible, be previously emptied.

The membranes also should be broken, the soft parts completely dilated, and the head of the child as far as possible advanced, previous to the use of any instrument.

The form and structure of the parts of the woman, the situation and progress of the presenting part of the child, must at this time be carefully considered. The convexity of the sacrum, for instance, will determine the progress of the labour. The touch of the vertex, fontanelle, lambdoidal, or sagittal suture, the fore or back part of the ear, or some part of the face, will ascertain the true presentation of the child.

The lower the head is advanced in the pelvis, our success with the forceps is the more to be depended on. For when it has proceeded as far as the inferior aperture, by means of this instrument, it may be readily relieved: but when the head of the child is con-

fined at the brim, both the application of instruments, and the extraction by this means, are exceedingly difficult and dangerous.

The head may be so firmly wedged in the pelvis, that the forceps can neither be introduced nor fixed without bruising or tearing the parts of the woman: wherever, therefore, insurmountable difficulties occur, either in applying or extracting with the forceps, the life of the mother must not be endangered by fruitless efforts; the head of the child must immediately be opened, and the delivery accomplished without further delay.

In laborious births, the proper forceps cases may be reduced to two, which include, however, a considerable variety. These are,

- I. The smooth part of the cranium,
- II. The face, presenting.

The head may present,

1st, Naturally, when low advanced in the pelvis, with the vertex to the pubes, and the forehead or face in the hollow of the sacrum. Or,

2dly, When higher in the pelvis, the vertex may present with the face laterally, the ears to the pubes and sacrum. Or,

3dly, The fontanel may present with the face to the pubes, and vertex to the sacrum; or with the vertex to the pubes, and face to the sacrum.

1. When the head presents naturally. The woman in this case must be placed on her back across the bed, properly supported; the accoucheur, seated before or in a kneeling posture, after gradually lubricating the perineum and vagina, must proceed gently to stretch the parts, by passing the hand in a conical manner through the os externum vaginae, pushing it forwards by the side of the child's head, till it advances as far as an ear, if possible; along this hand he is to guide a blade of the forceps, which with the other hand he introduces in the direction of the line of the pelvis, holding the handle backwards towards the perineum, and keeping the clam closely applied to the child's head. This must be insinuated very gradually by a kind of wriggling motion, pushing it on till the blade is applied along the side of the head over the ear: he must then gently withdraw the first hand from the pelvis, with which he must secure the handle of the blade of the forceps already introduced, till the other blade be passed along the other hand, in the same slow cautious manner: the handles must then be brought opposite to each other, carefully locked, and, lest they slip in extracting, properly secured by tying a fillet or garter round them; but this must be loosed during the remission of pulling, to prevent the brain from being injured by the pressure. The extraction must be made by very slow and gentle degrees, and with one hand only, while the other is employed to guard the perineum: the motion in pulling, should be from blade to blade; the accoucheur must rest from time to time, and, if the pains are not gone, should always in his efforts only co-operate with those of nature. The child and mother will suffer less by going on in this gradual manner than by precipitating the birth, which can never be done but at the risk of destroying both. If, in making the extraction, the forceps slip, they must be cautiously withdrawn blade by blade, and again introduced in the same manner.

manner. When the tumour of the perinæum forms, and the vertex begins to protrude at the os externum, the accoucheur must rise from his seat, raise the handle gently upwards, and, by a half-round turn, bring the hind-head from under the lymphis or arch of the pubes; remembering carefully to guard the perinæum from laceration and its consequences, to which it is now so greatly exposed.

In attempting the introduction of either blade, if it meets with any interruption, it must be as often withdrawn, and pushed up again in a proper direction, till every difficulty be surmounted; and if, from the smallness or contraction of the parts, the introduction of the second blade shall seem impracticable, the former one must be withdrawn, and the latter must be first introduced.

2. The vertex may present with the face laterally in the pelvis. It is always difficult to apply the forceps till the bulky part of the head has passed the brim; and here it is not only difficult to the operator, but extremely hazardous to the patient, to introduce this instrument till the ear of the child has got under the pubes. When the ears thus present to pubes and sacrum, the woman should be placed on her side or knees; the most difficult blade of the forceps should be first applied, which is the one under the pubes; when both are passed, and properly secured, the patient should again be turned to her back, before the operator attempts to extract, and the head in this case (as the quarter-turn can seldom be made with safety) should be delivered in the manner wherein it presents; because, when confined any time in the passage, its figure is altered by the overlapping of the bones, in such a manner that it passes along, in general, with far less difficulty than to attempt to push up and make the mechanical turns; a work often altogether impracticable, by which confusion or laceration of the parts of the woman, and the most fatal consequences, may be occasioned. The handles of the forceps must here particularly be well pressed backwards towards the perinæum, that the clams may humour the curvature and intrusion of the sacrum, and accommodate themselves to the form of the child's head.

This is a case wherein the forceps often fail; if so, they will sometimes succeed by varying the mode of application, and fixing them over the forehead and occiput; if this method fails also, the size of the head must be diminished, and the extraction made with the blunt hook or crotchet.

3. The fontanelle may present with the face to the pubes. This is the most common of the fontanelle cases; though sometimes the face is lateral in the pelvis, sometimes diagonal, and sometimes it is turned to the sacrum. The true position is ascertained by the direction of the fontanelle, and that of the ear. Here, as in other laborious births, nature should be intrusted as long as we dare. The head does not always descend mechanically through the capacity of the pelvis, as some practitioners have supposed; nor will the deviation from its ordinary mode of descent always of itself influence the delivery, at least very rarely in such a manner as to require extraordinary assistance. In whatever manner the head presents, when it is situated high in the pelvis, the delivery

cannot be effected without difficulty and hazard: in such circumstances, the application of the forceps will frequently baffle the utmost efforts of the accoucheur, and the consequences of such attempts may prove fatal to mother and child.

When extreme weakness in the mother, floodings, convulsions, or other urgent symptoms, render it necessary to force the delivery, whether the face be to pubes or sacrum, the forceps may be applied along the ears, in the same manner as directed in a natural labour; and the head, for the reasons already given, should be brought along in the manner it presents; the extraction should be made with great deliberation, that the parts of the woman may have time to stretch; the perinæum must be carefully supported; the forceps must be gently released, when the head is delivered; and the rest of the delivery conducted as in a natural labour.

In this case, when situated high in the pelvis, the fontanelle presenting, and the face either to pubes or sacrum, the long axis of the head intersects the short diameter of the pelvis, and very often, though the forceps be applied, and a firm hold of the head be obtained, it is not possible to bring it along with all the force we dare exert. If this method therefore fails, the common forceps should be cautiously withdrawn, and the long ones applied, if possible, over the fore-head and occiput, when, the size of the head, by the compression it suffers in passing along, being perhaps somewhat diminished, the extraction will be successfully performed. This method also failing, previous to the operation of embryotomy, Dr Leak's forceps, with the third blade, may be had recourse to. But of this little can be said with confidence, till the instrument has been more generally employed. From the difficulty of succeeding in the application of the common forceps, it may, *a priori*, be concluded, that the introduction of a third blade, even in the hands of an expert practitioner, however ingenious the invention, is an expedient not easily to be put in practice. Neither is Roonhuysen's lever, or a blade of the forceps passed up between the pubes and fore-head or hind-head of the child, in order to procure the delivery of the head, to be recommended in such cases: however some have boasted of its success, it is an instrument that may do much mischief; and few practitioners can use it with safety.

II. *Face presenting.*—Of laborious births, face-cases, as we have already observed, are the most difficult and the most dangerous. From its length, roughness, and inequality, the face must occasion greater pain; and from the solidity of the bones, it must yield to the propelling force with much more difficulty, than the smooth movable body of the cranium. Face-cases are the most troublesome that occur in the practice of midwifery, and in which the most expert practitioners may be foiled in their attempts; and these attempts, if too early exerted, will be followed in many instances with fatal consequences. Whatever way the face presents, it should be allowed to advance as low as possible in the pelvis; by which means, the access will be more easy, and the position, for the application of instruments, much favourable. In this awkward situation, much mischief may be done by rashness; whereas, if time be allowed, and the

the patient be properly supported, the delivery will generally end well.

The face may present with,

1. The chin to the pubes.
2. to the sacrum.
3. laterally.

From the difficulty of applying instruments in these cases, some authors recommend, as an universal practice, to turn the child, and deliver by the feet. But this in general is a dangerous practice, and seldom or never advisable, except when the membranes remain entire, till the os uteri is completely dilated, and the head continues loose above the brim of the pelvis: and even then the propriety of the practice is doubtful; because, if the head is small, or the pelvis be well proportioned, the face will descend without much difficulty; and if otherwise, besides the risk in attempting to turn, the child may be lost from the pressure of the chord, or the difficulty of extracting the head after the delivery of the body.

When assistance becomes necessary, the best practice in face-cases is the following: Having placed the patient in a convenient posture, let the accoucheur in the gentlest manner pass his hand within the pelvis; and, during the remission of pain only, endeavour to raise the head of the child, so that he may push up the shoulders entirely above the brim of the pelvis, and thus change the position of the face: by this means, if successful, he will be able to reduce the first of these cases, so as to make the fontanel present with the face to the pubes; he will reduce the second so as to bring down the vertex, with the face to the sacrum; and the third, he will reduce to a vertex case, with the face lateral. The delivery may be afterwards trusted to nature; which failing, there is easier access for the application of instruments to make the extraction, as already directed. The success, however, of the accoucheur, in altering the position of the head, by pushing it up, will entirely depend on the time he is called; for, should the head be firmly wedged in the pelvis, no force he dares employ will be sufficient to alter the posture.

If therefore every attempt to reduce the face, and make the vertex or fontanel present, shall prove unsuccessful, and symptoms are urgent, the forceps must be applied over the ears of the child, and the extraction performed in the best manner the operator is able. And, failing these, immediate recourse must be had to the crotchet.

1. In the first case, previous to the introduction of the forceps, the chin, if possible, should be advanced below the pubes.

2. In the second, the chin should be advanced to the inferior part of the sacrum. And,

3. In the third, the chin should be as low as the under-part of the tuber ischii: and although in general the head is to be extracted as it presents, if the operator meets with considerable resistance, it must be gently pushed up and turned with the chin, either laterally, below the pubes, or into the hollow of the sacrum, according to the particular circumstances of the case, and in a direction best accommodated to the form and diameter of the pelvis.

*Use of the Scissors, Crotchet, and Blunt Hook.*

When the head of the child, from its size, unfavourable position, or from a fault in the pelvis, cannot be protruded by the force of natural pains, nor extracted by the forceps, recourse must be had to more violent means, and the life of the child must be destroyed in order to preserve that of the mother. This operation was by the ancients called *embryotomy*.

When the head, from its extraordinary bulk, is detained at the brim of the pelvis; on evacuating the contents, the bones of the cranium immediately collapse, and the head is afterwards propelled by the force of the labour-pains; failing which only, the extraction must be made with the blunt-hook or crotchet.

The unfavourable position of the head is of itself a cause insufficient to justify the use of destructive instruments, which ought never to be employed but in extreme cases, after every milder method has failed. From the difficult access to the cranium in order to make a perforation and evacuate the brain, a face-case makes a very troublesome and dangerous crotchet one. Very luckily, in narrow pelvises, the face rarely presents, and very seldom advances far in that direction; at other times, the position may be so altered, that the crown, the back of the ear, or some other part of the cranium, can be reached; otherwise the crotchet must be fixed in the mouth, orbit of the eye, &c. and the head brought along in that direction, till the scissors can be employed to open the skull.

But the grand cause of difficult labour is, the narrowness or distortion of the pelvis. For when, at the brim, instead of four inches and a quarter from pubes to sacrum, it measures no more than one and a half, one and three-fourths, two, or two inches and one-fourth, the use of instruments becomes absolutely requisite, and very frequently in those of two inches and one-half, and three inches; or when the diameters through the capacity, or at the inferior aperture, are retrenched in the same proportion, difficulties will in like manner arise, and the delivery, except the labour be premature, or the child of a small size, cannot be accomplished without the assistance of destructive instruments.

We judge of the form and size of the pelvis by the external make and form of the woman; by the progress of the labour; by the touch. When the fault is at the inferior aperture, the touch is pretty decisive; e. g. if a bump is felt in the os sacrum instead of a concavity; if the coccyx is angulated; if the lymphitis pubis projects inwards in form of an acute angle; if the tuberosities of the ischia approach too near each other; or the one tuber be higher than the other; such appearances are infallible marks of a distorted pelvis. But when the narrowness is confined to the brim, this is only to be discovered by the introduction of the hand within the pelvis: the projection of the lumbar vertebrae over the sacrum, is a species of narrow pelvis, that most frequently occurs in practice. In this case, the child's head, by the pressure it sustains between pubes and sacrum, is moulded into a conical or figural form, the parietal bones are squeezed together, overlapping one another, and will be felt to the touch when the labour is advanced, like an acute ridge, something in the form of a fow's back.

Difficult  
Labour.Difficult  
Labour.

Instead of the complicated instrumental apparatus invented by the ancients, such as screws, hooks, &c. for fixing in, laying hold of, and extracting the head, as it presented, an operation in many cases difficult and dangerous, when the head was bulky or the pelvis narrow, as the woman frequently lost her life in the attempt; the practice of diminishing the size of the head, by opening the cranium and evacuating the brain, previous to the extraction, is a modern improvement, and an important one: the instruments for this purpose consist simply of a pair of long scissars, a sharp curved crotchet, and a blunt hook: these are preferable to every other, whether of ancient or modern construction.

When the accoucheur is under the disagreeable necessity of destroying the child to preserve the mother, she must be laid in the same position as already advised for the application of the forceps; and the same rules, recommended for the one operation, will in general apply to the other.

Thus, in the narrowest pelvis that occurs, previous to opening the cranium, the soft parts should be completely dilated, and the head of the child should be fixed steadily in the pelvis and advanced as far as possible; for while the head is high and loose above the brim, the application of instruments is very difficult as well as hazardous.

The long scissars must be cautiously introduced into the vagina, directed by the hand of the accoucheur; the points must be carefully guarded, till they press against the cranium of the child, which they must be made to perforate with a boring kind of motion, till they are pushed on as far as the resists; they must then be opened fully, carefully re-shut, half turned, and again widely opened, so as to make a crucial hole in the skull. They must afterwards be pushed beyond the resists, opened diagonally again and again, in such a manner as to tear and break to pieces the bones of the cranium; they must then be shut with great care, and withdrawn along the hand, in the same cautious manner as they were introduced, lest they should bruise or tear the uterus, vagina, or any other part of the woman. After a free opening in the cranium has thus been made, the brain must be scooped out with the fingers or blunt-hook, and the loose sharp pieces of bone must be carefully separated and removed, that no part of the woman be tore while the head is extracting. The teguments of the scalp should now be brought over the ragged bones of the cranium, and the woman should be allowed to rest an hour or two, according to her strength and other circumstances: the bones of the cranium will now collapse; and if the woman has as much strength remaining, or the pelvis be not much distorted, the head being thus diminished, will be protruded by the force of natural pains; otherwise it must be extracted, either by means of two fingers introduced within the cavity of the cranium, by the blunt-hook introduced in the same manner, guarding the point on the opposite side while making the extraction; or, failing these, by the crotchet, which, though dangerous in the hands of an ignorant rash operator, may be employed by the prudent practitioner with as much safety as the bluntest instrument.

The method of introduction is the same with a blade of the forceps. The chief thing to be attended to is,

to guard the point till it be applied against the head, and firmly fixed in its hold, which should always be somewhere on the outside of the cranium; provided a firm hold is obtained, no matter where, behind the ears, about the os petrosum, orbits of the eyes, maxilla inferior, &c. according to the presentation of the head. The woman being properly secured, and the handle of the instrument covered with a cloth, the operator must then pull, at first gently, afterwards more forcibly, resting from time to time, and endeavouring to make the extraction in the best manner the circumstances of the case will admit of. If the pelvis be much distorted, so that, by means of the utmost strength the accoucheur can exert, little purchase is made, he may apply to the opposite side a blade of the forceps, which are now so constructed as to lock with the crotchet; let him then bring the handles together, secure properly, and thus endeavour to make the extraction. Should this expedient also fail, the blade of the forceps must be withdrawn, the other blade of the crotchet must be applied, the handles brought together and secured, and the extraction made, moving from blade to blade.

Should the head present in such a manner, that, in attempting to extract it, the crotchet divides the vertebrae of the neck, and the head is thus severed from the body, an accident that can only happen in the hands of an ignorant blundering practitioner; the head must be pushed up above the brim of the pelvis, the crotchet or blunt hook must be fixed under the axilla, the arms must be brought down, and the body extracted, by fixing the crotchet below the scapula on the sternum, or among the ribs; the head must afterwards be extracted in the manner already advised: or should the head in extracting be pulled from the body, as may happen when the child has been long dead, or when it is putrid, the delivery of the body must be effected by means of the crotchet as now directed; a method preferable to that of turning, as some advise.

If the head, instead of yielding to the force of pulling, be at last cut and broken in pieces, the operator must endeavour to bring down an arm of the child, to fix the crotchet about the jaw or neck, pull at both holds, and thus attempt to make the extraction; this also failing, he must bring down the other arm, fix the crotchet in the thorax, and, in a word, must tear the child in pieces, that the delivery may be accomplished by any means.

In face-cases, where it is impracticable to alter the position, and when the pelvis is much distorted, the double crotchet is sometimes requisite; the handles must be well secured, kept well backwards towards the perineum, and the motion always from blade to blade. It very seldom, however, happens, that there is occasion for the double crotchet: by this means the head is flattened in pulling; whereas if one blade only can be employed, the head is lengthened, and, in pulling, can better accommodate itself to the shape of the pelvis as it passes along.

#### CHAP. XII. *Præternatural Labour.*

In whatever manner the child presents when the body is delivered before the head, the birth is accounted præternatural.

Præternatural labours may be referred to one of the four following classes.

I. When

## C L A S S I .

I. When one or both feet, knees, or the breech, present.

II. When the child lies across in a rounded or oval form, with the arm, shoulder, side, back, or belly, presenting.

III. When one or both of the upper extremities present, the child lying in the form of a sheath, the feet towards the fundus uteri, the waters evacuated, and the uterus strongly contracted round the body of the child.

IV. Lastly, Premature or flooding cases, or others in which it may be necessary to force the delivery, either previous to the rupture of the membranes, or quickly after it.

The causes of cross labours most commonly assigned by authors, are, The obliquity of the uterus, a circumvolution of the funis umbilicalis round the child's body; the shortness of the funis, or attachment of the placenta towards the fundus uteri; shocks affecting the mother when pregnant, &c. The position of the fœtus may also be influenced by its own motion and stirrings, by the particular form and bulk of its body, by the manner of stretching of the uterus, by the quantity of liquor amnii, and by many other circumstances.

The symptoms that indicate an unfavourable position of the child, before it can be discovered by the touch, are very uncertain and fallacious: a cross birth may, however, be suspected,

1<sup>st</sup>, If the pains be more slack and trifling than ordinary.

2<sup>dly</sup>, If the membranes be protruded in a long form like a gut, or the finger of a glove.

3<sup>dly</sup>, If no part of the child can be discovered when the uterine orifice is considerably opened.

4<sup>thly</sup>, If the presenting part through the membranes be smaller, feels lighter, and gives less resistance than the bulky ponderous head.

5<sup>thly</sup>, Lastly, after the rupture of the membranes, if the meconium of the child be passed along with the waters, it is a sign that the breech presents, or that the child is dead.

Preternatural labours are difficult or hazardous, according to,

1. The form of the pelvis, and general health and constitution of the woman.

2. The bulk of the child, and its manner of presenting.

3. The time the waters have been evacuated, and the uterus contracted round the body of the child.

4. When complicated with plurality of children; the prolapsus of the funis umbilicalis; the limbs of the child entangled with the chord; profuse and violent floodings from the attachment of the placenta towards the cervix uteri, &c.

Turning is often laborious, and always dangerous in proportion to the force used in searching for and bringing down the feet; though, in general, the difficulty and hazard are not so great, as in many cases strictly called *laborious*, when the head presents; the treatment of preternatural labours being better known, and for the most part easier put in practice.

Each class of the general division of cross labours includes a variety of different cases. By considering a few of every class, a general idea of the whole will be formed.

CASE I. The simplest and easiest case is the Agrippan posture, when the child presents with the feet.

The foot is to be distinguished from the hand, first, by the weight and resistance it gives to the touch; secondly, by the shortness of the toes; thirdly, by the projecting heel.

When the feet present in the passage, the labour should be allowed to go on as if natural. If the child be of an ordinary size, the woman in health, the parts well proportioned, in the way of assistance nothing further seems necessary but the application of a warm cloth round the body of the child, which must be properly supported till it advances as far as the pains are able to force it. If the size be ordinary, or rather small, it will sometimes make the mechanical turns, and be entirely pushed along by the force of the natural pains; but it generally stops at the shoulders, after the breech protrudes without the os externum, where the resistance is so great, that the accoucheur's assistance becomes requisite.

In this case, the patient must be placed on her back, properly supported; the hand of the accoucheur must be cautiously introduced; the parts of the woman must be gently stretched; the feet of the child must be laid hold of, and brought as low in the vagina as possible; a soft warm cloth must be wrapped round them, and the extraction must be performed in a slow, cautious manner, making large motions in a circular or lateral direction, resting from time to time, if the pains are gone; and if not, always waiting for the natural efforts. When advanced as far as the breech, the body, if not already in a proper direction, must be pushed up, and gently turned with the face towards the mother's back; and to make sure that the face turns with the body, or to prevent the chin, vertex, or shoulders from catching on the pubes, or angle of the sacrum, an extraordinary quarter-turn more must be made: this must be reversed previous to the extraction; and the difficulty arising from the obstruction of the shoulders must be removed in the following manner. While the breast and legs of the child are supported over the palm and forearm of the one hand of the accoucheur, which he draws towards one side, he must introduce two fingers of the other hand at the opposite side into the vagina, over the back-part of the shoulder, as far as the elbow, and endeavour in the most gentle manner to bring down the arm, always remembering, in his movements, to humour the natural motions of the joint: he must then shift hands, when the other arm is to be relieved in the same manner: both arms being brought down, the woman must now rest a little, when a pain or two generally follows, and the head is also forced along. But should the woman be much exhausted, and if the head does not quickly advance, the child may be lost from delay. The extraction of the head in preternatural labours, is often the most difficult and the most dangerous part of the delivery; the cause of resistance, when it does not advance, is chiefly owing to its confinement between the angle of the sacrum and pubes, when the bulky part of the head is detained at the brim; whether the resistance be here or towards the inferior aperture of the pelvis, if the head does not advance in a pain or two, the extraction must be made in this manner:

Preternatural Labour.

ner: While the right hand of the accoucheur supports the body of the child below, with two fingers pressing on either shoulder, the left hand and fingers must in the same manner be placed over the back of the neck, and pulling gently in the direction from pubes to sacrum, he must thus endeavour to bring it along: but, should the pelvis be narrow, or the child's head of a large size, or the face be laterally or anteriorly placed in the pelvis, or, what rarely happens, the os uteri contracted round the neck of the child; in either of these cases, the accoucheur will sometimes meet with the utmost difficulty. When the above method therefore fails, he must introduce two fingers of the right-hand into the child's mouth, while those of the left-hand are expanded over the shoulders, as already directed; and in this way he must endeavour to relieve it, pulling from pubes to sacrum, alternately raising and depressing the head till it advances low down, so that the face descends from the hollow of the sacrum, when the accoucheur must rise from his seat, and bring the hind-head from under the pubes with a half-round turn, imitating that of a natural labour.

If the position be unfavourable, the face, if possible, should be turned to the sacrum, by pushing up the head, or by pushing back the chin: If the contraction of the uterus is the cause of resistance, which rarely occurs, it must be gently stretched with the fingers. Or if the difficulty arises from circumvolutions of the chord round the legs, thighs, body, or neck of the child, these must be disengaged in the easiest manner possible; it is rarely necessary to divide the funis on this account.

Should every method fail in bringing down the head, the delivery must be effected by means of the forceps cautiously passed over the ears, with the handles under the child's body, in a direction downwards towards the perineum. If the pelvis be very narrow, or the head of a large size, it must be opened by pushing the scissars through the occipital bone, so that the contents of the cranium may be evacuated, and the extraction made by means of the forceps, blunt-hook, or crotchet. But if the head, by the efforts to extract it, be actually severed from the body, and left behind in the uterus, an accident which sometimes occurs, it must be delivered by inclosing it in the forceps, while secured from rolling by pressing externally on the abdomen. If the forceps cannot be applied, the cranium must be opened, the texture of the brain destroyed, and the extraction performed by the fingers of the accoucheur, by the blunt-hook, or by the crotchet. If the under-jaw remains, the head may be effectually secured till locked in the forceps, or till its bulk be diminished, by introducing a finger into the mouth, thrusting it through the jaw under the chin, drawing it down, and passing a ligature through the perforation.

In cases where the child has been long dead, should the belly or thorax be distended with air or water, and prove the cause of obstruction, the contents must be evacuated by opening with the scissars, or tearing with the crotchet; and in general, where difficulties occur, the delivery must be accomplished in that manner the circumstances of the case will best admit of.

*Case 2.* When instead of two, one foot only falls  
Vol. VII.

Preternatural Labour.

into the vagina, the other is sometimes detained by catching on the pubes, and, if easily come at, should be brought down, always remembering to humour the natural motion of the joint; but, should the leg be folded up along the child's body, the attempt is sometimes both difficult and dangerous, and ought not to be perfited in, as the breech will either be forced down by the assistance of natural pains, or by gently pulling by one leg only.

*Case 3.* When one or both knees present, the delivery must be conducted in the same manner with that of the feet.

*Case 4.* When the feet offer along with the breech, this last must be pushed up, while the former are secured and brought down, till it be reduced to a footing case, and otherwise managed as above.

*Case 5.* The breech may present with the fore-parts to the mother,

1<sup>st</sup>, Anteriorly.

2<sup>dly</sup>, Laterally. Or,

3<sup>dly</sup>, Posteriorly.

Sometimes the breech may be discovered, previous to the rupture of the membranes; but afterwards with more certainty, by the mœonion of the child passed with the waters, and by the touch.

In whatever manner the breech presents, the delivery should be submitted to nature, till the child be advanced as far as the thorax, when the feet are to be brought down and laid hold of, the child, if necessary, pushed up, the mechanical turas effected, and the delivery otherwise conducted as in a footing case. There is much less hazard in general, agreeable to an old observation of Mauriceau, in allowing the child to advance double, than in precipitating the extraction by pushing up to bring down the feet before the parts have been sufficiently dilated; a practice difficult and troublesome to the operator; painful, and sometimes dangerous, to the mother; and by which the child is exposed to the risk of strangulation, from the retention of the head after the delivery of the body. If the child be small, though doubled, it will easily pass in that direction; if large, though the labour be painful, the natural throes are less violent and less dangerous than the prepotent help of the accoucheur: If the child thus advances naturally, it will be less exposed to suffer; if it does not advance, the parts of the mother will be prepared for the accoucheur to pass his hand into the pelvis, to raise up the breech, to bring down one or both feet, and deliver as above.

Weakeness in the mother, floodings and convulsions, a very large child, or narrow pelvis, the prolapsus of the funis, or its compression between the thighs of the child, or between the child and pelvis, by which its life is endangered, if the chord cannot be reduced above the presenting part, are the only exceptions to the general rule of treating the breech as a natural labour.

The practice of helping forward the breech, by passing the blunt-hook under the ham, is now entirely laid aside: this can never be done with safety, till the breech be so low advanced, that the hand of the accoucheur can be used, which may be employed with more advantage as well as safety.

## C L A S S II.

In the former class of preternatural labours, it is advisable to trust to nature in many cases, as the birth will often be accomplished without manual assistance: but when the child lies a-cross, no force of pain can make it advance in that position; and, without proper assistance, both the mother and child would perish.

If the accoucheur has the management of the labour from the beginning, the child may be turned, in the worst position, without difficulty; but when the waters have been for some time evacuated, and the uterus strongly contracted, turning is laborious to the operator, painful and dangerous to the mother. In such cases, the ancients endeavoured to make the head present; but, from its bulk, they often failed, and the attempt was often attended with fatal consequences. The method of delivering by the feet is the most important modern improvement in the practice of midwifery; an improvement to which many thousands owe their lives.

When the child lies in a transverse position, the accoucheur must insinuate his hand through the vagina into the uterus in the gentlest manner, search for the feet, bring them down with the utmost caution, and finish the delivery as in footling-cases. To effect this, the following rules should be observed.

1. The patient must be placed in a convenient posture, that the operator may be able to employ either hand, as the various circumstances of the case may require.

2. Though the best posture, in general, is laying the woman on her back, it will be sometimes necessary to turn her to her side; and, in these cases, where the abdomen is pendulous, where it is difficult to reach the feet, or where they lie towards the fundus uteri, the woman should be placed on her knees and elbows.

3. An exact knowledge of the true position of the child, and of the structure and state of the parts, should be acquired, before attempting to make the delivery.

4. The orifice of the uterus should be enlarged, so as freely to admit the hand; and the strong pains should be abated, before any attempt be made to deliver.

5. Should the waters be drained off, the parts dry and rigid, and the uterus contracted round the child, warm oil must be injected into the uterus, otherwise its rupture may be endangered.

6. In passing the hand into the uterus, this must be done in the gentlest manner; the parts must be well lubricated with butter or pomatum; the line of the pelvis must be attended to; the efforts of the operator must be slow and gradual; and thus the utmost rigidity in the soft parts will, in time, be overcome.

7. The hand must be introduced only during the remission of pain; when pain comes, the accoucheur must always rest; otherwise he may push his hand, or the fetus, through the body of the uterus.

8. In pushing up, to come at the feet, this must never be done with the points of the fingers, nor with the hand clenched, but with the palm of the hand, or

the broad expanded fingers, and always during the remission of pain, and the latter should also be observed in bringing down the legs; but, in making the extraction of the body, the efforts of the operator should always co-operate with those of nature.

9. The hand should, if possible, be introduced along the anterior parts of the child; and both feet, if easily come at, should be laid hold of.

10. In turning, the accoucheur should never consider the child as dead, nor allow himself to be deceived by symptoms doubtful and fallacious; the child is sometimes born alive when he would least of all expect it; therefore, in pushing up, bringing down the legs, or extracting the body, it should be handled with the greatest delicacy.

11. When the hand is within the pelvis, it should not always be moved in the line of the umbilicus, but rather towards one side of the spine, by which more room is gained, and the prominent angle of the sacrum avoided.

12. The hand should be passed as far as the middle of the child's body, before attempting to search for the feet; or before attempting to break the membranes, should they remain entire, till the aperture of the uterus will admit of the hand.

13. If the hand cannot pass the presenting part of the child to come at the feet, instead of violently pushing back, the part should be as it were lifted up in the pelvis, and moved towards a side; by which means difficulties may be surmounted, and great danger often prevented.

By attending carefully to the above rules, laceration of the uterus, floodings, convulsions, inflammations, and their consequences, may be prevented; accidents that frequently happen in the hands of ignorant rash operators.

*Case 1.—The arm presenting.* The right is to be distinguished from the left by laying hold of the child's hand, in the same manner as in shaking hands; and thus the general position of the child may be judged of.

When the accoucheur is called in early, the reduction is generally practicable: but if the arm protrudes through the vagina, and the shoulder be locked in the pelvis, it is needless, by fruitless efforts, for the accoucheur to fatigue himself, and distress his patient, to attain a point by which he will gain no very material advantage; as the hand can be passed into the uterus by the side of the child's arm, which will, of course, return into the uterus when the feet are brought down into the vagina.

In order to make the delivery, the hand of the accoucheur, well lubricated, must be conducted into the uterus by the side of the child's arm, along the thorax, at the opposite side of the pelvis where the head lies; if any difficulty occurs in coming at the feet, this hand must be withdrawn, and the other introduced in its stead; and if still the hand cannot easily pass beyond the child's head or shoulder, the presenting part must be raised up, or gently pushed to a side, that one or both feet may be laid hold of, which must be brought as low as possible, pushing up the head and shoulders, and pulling down the feet alternately, till they advance into the vagina, or so low that a noose or fillet can be applied; and thus by pulling with



with the one hand by means of the noose, and pushing with the other, the feet can be brought down and the delivery finished, however difficult.

The method of forming the noose is by passing the two ends of a tape or garter through the middle when doubled; or should the garter be thick, by making an eye on one extremity, and passing the other end through it: this, mounted on the points of the fingers and thumb of the accoucheur's hand, must be conveyed into the uterus, passed over one or both feet and ankles, and secured by pulling at the other extremity.

*Case 2.—The side.* This is discovered by feeling the ribs.

*Case 3.—The back.* This is discovered by feeling the spine.

*Case 4.—The belly.* This is known by the funis.

These cases occur rarely, as the uterus must with difficulty admit of such positions. When any of these parts do present, the child seldom passes any part of the brim of the pelvis, and is, in general, more easily turned than in several postures in which it may offer. The belly, from the difficulty with which the legs can be bended backwards, except the child be flaccid, putrid, or before the time, will very seldom directly present; if so, it will be early and readily discovered by the prolapsus of the funis, and there will be no great difficulty to come at the feet, and deliver. The rule in all these cases is, to pass the hand into the womb in the gentlest manner possible, and to search for the feet and bring them down.

### C L A S S III.

WHEN the child lies longitudinally in the uterus, with the arm or shoulder presenting, and the head more or less over the pubes, or laterally in the pelvis, the feet towards the fundus uteri, the waters evacuated, and uterus contracted round the child's body; these are the most difficult and laborious of all the cases of preternatural labours. Here the protruding arm ought, if possible, to be reduced, and the head brought into the pelvis; for unless the child be very small, it is impossible for the head and arm to pass along together.

In order to effect the reduction of the arm, different instruments have been invented; but the hand of the accoucheur is preferable to every thing of this kind, whether of ancient or modern invention. This, conducted by the arm that protrudes, must be insinuated through the vagina into the uterus, as far as the shoulder of the child, which, if the accoucheur can raise up, he will generally succeed in reducing the arm. Should this method fail, he must attempt to push up the fore-arm at the elbow; but, in bending it, must be very cautious, to avoid overstraining or dislocating the joint. In whatever manner the reduction is accomplished, if any method proves successful, the arm must be retained till the head, by the force of natural pain, enters the pelvis, and prevents its return; otherwise the arm will descend, as often as it is reduced.

But if the attempts for reduction prove impracticable, the woman must be placed on her knees and elbows, and the accoucheur, with great deliberation, must endeavour gently to slide up his hand between

the uterus and child as far in the uterus as possible, to lift up the head and shoulders, and search for and bring down one or both feet, in the best manner the various circumstances of the case will admit of. As soon as they can be laid hold of, they must be gradually brought down into the vagina, so low that the noose can be applied over them, which must be fixed and pulled with the one hand, while the head and upper parts of the body are raised and gently pushed up with the other.

Should the arm have been long protruded without the os externum, much swelled, and cold; the waters drained off; the uterus strongly contracted; and the position of the child such as to render it impracticable, either to reduce the protruded limb, or to search for and bring down the feet; the head, if easily come at, must be opened and extracted with the blunt-hook or crochet; or a crochet must be fixed amongst the ribs, and the breech or feet thus pulled down.

Should the pelvis be very narrow, and unfurmountable difficulties occur, the arm must be twisted off at the elbow, though this expedient is rarely necessary; and the delivery must in general be accomplished as the prudence and judgment of the operator can best direct; always remembering, when one life must fall a sacrifice, that the tree must be preserved at the expense of the fruit.

In this, as in other cases, the swelling and coldness of the arm, and even wast of pulsation in the artery, are not infallible signs of the child's death; and should this even be so, it makes little difference in the mode of delivery, unless that it will lead us to pay all our attention to the mother: For a living child gives no more assistance in the birth than a dead one, whatever authors have said to the contrary.

When both arms present, the delivery must be conducted in the same manner as when one only presents. The former case is less difficult than the latter, as the head seldom advances far when both arms fall into the passage, so that they can either be reduced, or there is easy access to come at the feet to bring them down and deliver.

### C L A S S IV.

WHEN the membranes remain entire, till the soft parts are so much dilated, that the hand will readily find admittance; or when the hand can be passed within the cavity of the uterus, immediately after the rupture of the membranes, so that part of the water may be retained; the delivery may be accomplished, in the most troublesome preternatural cases, with the greatest safety and expedition. But when the waters have been long evacuated, and the uterus closely contracted round the body of the child, the case will prove laborious to the operator, painful and dangerous to the mother and child.

When there is reason to suspect that the child lies across, which can often be ascertained, either by feeling the presenting part through the membranes, or by some of the signs of preternatural labours already mentioned; the woman should be managed in such a manner, that the membranes may be preserved entire as long as possible; for this purpose she should keep quiet in bed, and her posture should be such as is least favourable for straining, or exerting force during the

Preternatural Labour.

pain: she should be touched as seldom as possible, till the os uterum be sufficiently dilated. The accoucheur should then introduce his hand in a conical form, well lubricated, into the vagina, and through the aperture of the internal orifice, insinuating it between the uterus and the membranes, till it advances almost as high as the fundus uteri, when he must break the membranes, by pinching some part of them between a finger and thumb, or by forcibly pushing a finger thro' them; he must then search for, and endeavour to lay hold of, one or both feet, and deliver.

Should the membranes be ruptured in the attempt, he must be ready to run up his hand as quickly as can be done with safety, when, part of the waters by his arm being retained, the operation of turning will be facilitated. Should the placenta adhere on that side of the uterus where the hand is passed, it must again be withdrawn, and the other hand be introduced in the opposite side.

Floodings. It has been already observed, that a flooding seldom proves fatal to the mother before the seventh month of pregnancy; after which period, from its duration or excess, the life of both the mother and child may suffer. Should therefore a flooding attack a woman in the two last months of pregnancy, from whatever cause it may arise, and whether attended with labour-pains or not, if the hæmorrhage be so considerable that she is ready to sink under it, and that cold applications and other means of checking the evacuation shall fail, the woman must be placed in a proper posture, her friends prudently apprised of her danger, and the delivery must be immediately performed, by stretching the vagina and os uteri, till the hand of the operator can easily gain admittance to break the membranes, catch hold of the feet, and extract the child.

If it can possibly be prevented, the membranes in flooding cases should never be broken till the aperture of the uterine orifice will freely admit the hand to pass, that, after the evacuation of the waters, the accoucheur may have it in his power either to make the delivery or not, according as the effusion continues or abates.

Soon after attempting to stretch the parts, should the labour-pains come on, the waters begin to be collected, and the uterine hæmorrhage diminish, the accoucheur must then withdraw his hand, and manage the delivery according to circumstances. And if, for instance, the child presents naturally, the delivery must be trusted to nature; otherwise, if the flooding continues, or the child presents across, the accoucheur must persist in his work, going on slowly, and with the utmost delicacy, till he be able to reach the feet, to bring them down, and deliver; always remembering, during this process, that the strength of the woman, by proper nourishment, be supported.

But should the placenta adhere to the cervix, or upon the os uteri, the greatest danger is to be dreaded; for thus the flooding will commence from the moment the os uteri begins to stretch, and will increase so rapidly, that the woman, if not speedily delivered, must inevitably sink under it. The whole body of the placenta, in such cases, is sometimes separated when the labour has made but little progress; so that the woman will often perish, whether delivery be attempted

or not. As this, however, is the only expedient by which her life, and that of the child, can be saved; in every case where the placenta presents, which the accoucheur will readily discover by the touch of the soft pappy substance of that body, he must immediately place the woman in a proper posture, insinuate his hand gently by the side of the protruding placenta, break the membranes, search for the feet of the child, and bring them down, so that the delivery may be finished with all possible expedition; for, in this unhappy case, a few minutes delay may prove fatal.

The after-birth ought never to be extracted before the child, if it can possibly be avoided.

After delivery, time should be given for the uterus to contract, that nature may thus throw off the placenta, which never ought to be hurried away, unless the continuance or a recurrence of the hæmorrhage render it necessary.

Prolapus of the funis. Difficulties arising from the funis falling down into the vagina, and presenting along with some part of the child, may, in this class of the division of pretermatal labours, be included.

A pressure on the chord, in such a degree as to interrupt the circulation, must infallibly destroy the life of the child: hence a coldness and want of pulsation in the chord is the truest criterion of the death of the child; and hence, in every case where the chord is prolapsed before any bulky part of the child, if the delivery be not accomplished with expedition, the child will perish. This is only to be prevented by replacing the chord, and retaining it above the presenting part, till this last, by the force of labour-pains, be so far advanced as to prevent the return of the former; or the child must be turned and brought by the feet, provided this can be done with safety to the mother. But it is often difficult to succeed in the attempt of the one or other; and, if the woman has strong pains, such attempts are not to be hazarded, as the consequences may prove fatal.

When the accoucheur is thus situated between two puzzling difficulties, the preference must always be given to the mother. If the child be small, and the pelvis well formed, which may be known by the history of former deliveries, and if the labour goes on quickly, the child will generally be born alive; but if, on the contrary, the child be above the ordinary size, and the pelvis rather narrow, turning will prove a dangerous operation to the mother, and there is little prospect of saving the infant by this means.

Besides our former division of labours, *plurality of children, monstrosities, extra-uterine fetuses, and the Cesarean operation*, are parts of the subject that yet remain to be considered.

#### CHAP. XIII. *Plurality of Children.*

The case of twins often occurs: of triplets seldom: of quadruplets rarely: nor is there perhaps a single instance, where five or more distinct fetuses have been found contained in the human uterus, though many such fabulous histories have been recorded by credulous authors.

The signs of two or more children, such as the sudden or extraordinary increase of the uterine tumour, motion felt in different parts of the abdomen, &c. are

very doubtful and fallacious: this can only be ascertained after the delivery of one child; and even then a recurrence or continuance of labour-pains is not a certain and infallible criterion; neither is the absence of pains a sure indication of the contrary; as many cases have occurred, where several days have intervened between the birth of a first and second child. The chief symptoms to be depended on are, 1st, The child being of a small size, and the quantity of liquor amnii so inconsiderable as not to account for the bulk of the woman in time of pregnancy. 2dly, The bleeding from the funis umbilicalis next the mother. 3dly, The remora of the placenta. 4thly, The uterine tumour not sensibly diminished, which, very soon after delivery, in ordinary births, will be found gradually shifting lower and lower, and will feel at last as if a hard circumscribed tumour like a ball between the umbilicus and pubes. Hence the utility of the general practice of applying the hand externally on the abdomen, in every case after delivery; by which an accurate knowledge will be formed of the nature and manner of the uterine contraction. When, from any of these circumstances, there is reason to suspect another child, the most certain and infallible method of discovering it is, the passing of a finger, or the introduction of the hand, into the uterus, where another set of membranes will be perceived, and probably some part of the child presenting through them.

The position of twins or triplets is commonly that which is most commodious, and which will occupy the least room in utero: their situation is often diagonal; tho' they may present in every possible posture. Thus, therefore, the general rules recommended for the delivery of one child, are equally applicable in the case of twins, triplets, &c.

It has been the general practice with many, after the birth of one child, to pass the hand immediately into the uterus, to break the membranes, catch hold of the feet of the child, and thus deliver. But this is certainly bad practice, whatever authors have said to the contrary. If the woman is healthy, and the child presents favourably, that is, with the head, breech, or feet, natural pains ought to be waited for, when the child will be expelled by the force of these only; failing which, manual assistance, as in other cases, must be had recourse to.

It very rarely happens, when the first birth is preternatural, that the second membranes are ruptured in making the extraction. Should this prove the case, the limbs of the children may be confounded, so that a leg and an arm, or three legs, or arms of different children, may present; which, however, will make little difference in the mode of delivery: the accoucheur will endeavour to lay hold of the foot or feet most readily within his reach, and will be cautious in bringing them down, to make sure they belong to the same body.

If the child presents crooked; if floodings, convulsions, or other dangerous symptoms, shall take place; if the woman has suffered much in the first labour; and if, after several hours, a recurrence of labour-pains does not ensue; the hand must then be introduced into the uterus, the membranes must be broken, and the child must be extracted by the feet: or, if the head remains locked in the pelvis, and, from want of strength in the

woman, cannot be expelled, the treatment is the same as in other laborious births.

In twin-cases it may be recommended as a general rule, to avoid precipitating the delivery of the second child till the woman shall have rested a proper time, and till, by the contraction of the fundus uteri, the second set of membranes occupy the place of the first, and be protruded as far as the os externum, when, and not before, the delivery may safely be assisted, should circumstances occur to render such assistance necessary: whereas, by breaking the membranes and evacuating the waters when the child lies high in the uterus, a flooding may be brought on, or a spasmodic constriction of the uterus round the body of the child may be occasioned, which may render the delivery both difficult and dangerous.

The placenta of twins, triplets, &c. generally adhere, though sometimes they are distinct, and may be thrown off at different times after the birth of the different children; so that the practitioner should be on his guard, and never should leave his patient till he makes sure there be no more children. When a second child is discovered, no attempts ought to be made to extract the placenta till after the birth of the remaining child or children; as the woman would be subject to flooding, which might prove of fatal consequence before the uterus could be emptied of its contents.

In case of plurality of children, a second ligature should be applied on the funis, on that end next the mother, immediately after the birth of every child; and a gentle compression should be made on the abdomen of the woman after the first delivery, which must be gradually tightened after every succeeding one, to prevent the consequences of a sudden removal of uterine pressure, which is to be dreaded where the distention has been considerable.

The placenta, in such cases, must be managed in much the same manner as usual. In twins, &c. it generally separates with great facility, provided time has been given for the uterus to contract. Both chords should be gently pulled; and when it advances towards the uterine orifice, where, being large and bulky, it commonly meets with considerable resistance, it requires the introduction of a finger or two into the vagina for bringing down the edge, after which the body readily follows.

#### CHAP. XIV. Monsters.

THESE are of various sizes and forms, and, unless very small, the posture favourable, and the woman well made, will prove the cause of a difficult and troublesome delivery. Sometimes a child is monstrous from a preternatural conformation of parts, such as a monstrous head, thorax, abdomen, &c. At other times, there is a double set of parts, as two heads, two bodies with one head, four arms, legs, &c. But such appearances very seldom occur in practice; and, when they do, the delivery must be regulated entirely according to the circumstances of the case. A large head, thorax, or belly, must be opened. If two bodies united together are too bulky to pass entire, they must be separated; the same of supernumerary limbs. If the posture be unfavourable, it must be reduced when practicable; otherwise the extraction

must be made with the crotchet, in the best manner the circumstances of the case will admit of; always, in cases of danger or difficulty, giving the preference to the safety of the mother, without regarding that of the child.

#### CHAP. XV. *Cæsarean Operation.*

WHEN the delivery could not be accomplished by other means, or when a woman died suddenly with a living child in her belly, an operation to preserve the life of mother and child in the former case, and to save the child in the latter, has been recommended, and successfully performed, by different authors, and in different ages.

This operation is of ancient date; it is the *setio Cæsarea* or *partus Cæsareus* of the Latins, and the *hysterotomia* of the Greeks. Whether it was ever successfully performed on the living subject amongst the ancients, seems uncertain; but that it has been successfully practised by the moderns on various occasions, and in several different countries of Europe, there are so many authentic histories on record, that the fact will scarce admit of doubt: but as this, like many other salutary institutions, has been much abused, and in many cases improperly and injudiciously employed, (for some of those women who survived the operation, were afterwards safely delivered of living children), the circumstances which render this operation necessary, demand a very particular inquiry, viz.

1. A narrowness, or bad conformation of the bones of the pelvis.
2. Imperforated vagina, or contractions in the vagina, cicatrices, tumors, or callosities in the os uteri, &c.
3. The escape of the child through the uterus when torn.
4. Ventral conceptions.
5. Hernie of the uterus.
6. The position or bulk of the child.

It will be necessary carefully to examine these different causes, in order to shew, that they are by no means, in every case, sufficiently powerful motives for having recourse to it.

I. Bad conformation of the bones of the pelvis. When the hand of the operator cannot be introduced within the pelvis; or, in other words, when its largest diameter does not exceed one inch, or one inch and a half, this conformation is perhaps the only one which renders the Cæsarean operation absolutely necessary: happily, however, such a fracture very seldom occurs in practice; and when it does, the accoucheur will readily discover it, by attending to the following circumstances, and to the common marks of a narrow pelvis. Wherever the capacity of the pelvis is so strait as not to admit any part of the child's head to enter, nor two fingers of the accoucheur's hand to conduct proper instruments to tear, break down, and extract the child piece-meal; in this case, recourse must be had to the Cæsarean section: an expedient, though dreadful and hazardous, that will give the woman and child the only chance of life; and which, if timely and prudently conducted, notwithstanding of the many instances wherein it has failed, may be performed with some probability of success.

It is true, the success of the operation in the city of Edinburgh, where it has been done five times, has

proved discouraging, as none of the women had the good fortune to survive it many days. This, however, is not the fault of the operation; but is to be imputed to the low, weak state of the patients at the time, who had previously been several days in labour, and their strength greatly exhausted, before the operator was called. Delivery by every other means was utterly impracticable; the operation, tho' the event was doubtful, alone gave a chance of life; and three of the children by this means were extracted alive.

Mr Hamilton Surgeon and professor of midwifery in Edinburgh, having been an eye-witness of the operation the last time it was performed here, gives the following account of the case which fell under his observation.

Elizabeth Clerk, aged 30, had been married for several years, became pregnant, and miscarried in the third month; the expulsion of the abortion occasioned so severe a stress, as actually to lacerate the perinæum. Some time after her recovery, she was irregular, afterwards had one shew of the menses, again conceived, and the child, as she imagined, arrived at full time. She was attacked on Monday the 3d of January 1774, about midnight, with labour-pains, which went on slowly, gradually increasing till Saturday the 15th, when she was brought from the country to the Royal Infirmary here. Upon examination, the pelvis seemed considerably distorted; but the body was otherwise well shaped, though of small size; the os externum vaginæ was entirely shut up, nor could any vestige of vagina be observed, nor any appearance of labia pudendorum: instead of this, there was a small aperture at the superior part of the vulva, immediately under the mons veneris, probably about the middle anterior part of the symphysis pubis. This aperture (which had a small process on the superior part, somewhat resembling the clitoris) was no larger than just to allow the introduction of a finger; the meatus urinarius lay concealed within it: a consultation of Surgeons was called, and the Cæsarian section was determined on. Having had no stool, nor voided any urine for two days, an injection was attempted to be thrown up; but it did not pass, nor was it possible to push the female catheter into the bladder. Mr William Chalmers was the operator in this case. At six in the evening, he made an incision on the left side of the abdomen in the ordinary way, through the integuments, till the peritonæum was exposed; two small arteries sprung, which were soon stopped by a slight compression: the wound was then continued through the peritonæum into the cavity of the abdomen, when the bladder appeared, slightly inflamed, much distended, reaching with its fundus near as far as the serobiculus cordis: another unsuccessful attempt was made to pass the female catheter; at length a male catheter was procured, which was, after some difficulty, introduced into the bladder, and the urine evacuated to the quantity of above four pounds, high-funnelled and fetid. This occasioned a necessary interruption for a few minutes, between making the opening into the abdomen and uterus; the bladder collapsing, the uterus, which before lay concealed, now came in view, through which an incision was made, and a stout male child was extracted alive; and immediately afterwards the secundines. The uterus contracted rapidly. After cleansing the wound, the lips were brought together by the quill-suture, and

closed

dressed ſuperficially. The patient ſupported the operation with ſurprizing courage and reſolution; nor was there more than five or ſix ounces of blood loſt on the occaſion.

Being laid in bed, ſhe complained of ſickneſs, and had a flight fit of vomiting; but, by means of an anodyne, theſe ſymptoms ſoon abated: ſhe was affected with univerſal coldneſs over her body, which alſo abated on the application of warm irons to the feet: ſhe then became eaſy, and ſlept for four or five hours. Next morning, the 16th, about two o'clock, ſhe complained of conſiderable pain in the oppoſite ſide, for which ſhe was blooded; and an injection was given, but without effect; for the pain increaſed, ſtretching from the right ſide to the ſcrobiculus cordis; nor did fomentations ſeem to relieve her; her pulſe became frequent, ſhe was hot, and complained of drought. At 7 A. M. the injection was repeated, but with no better ſucceſs; and eight ounces more of blood were taken from the arm; a third injection ſtill failed to evacuate any ſæces; the drought increaſed; and the pulſe roſe to 128 ſtrokes in a minute. At 11 A. M. the pulſe became fuller; and the reſpiration much oppreſſed. No ſtool nor urine paſſed ſince the operation. At 12 the blood was again, when the ſizeneſs appeared leſs than formerly. She now took a ſolution of *ſal Glauberi, manna* and *cr. tart.* at ſhort intervals; ſhe vomited a little after the laſt doſe, had a ſoft ſtool, and voided a ſmall quantity of urine. At 3 P. M. her pulſe was 136, and ſhe had another ſtool, when thin ſæces were evacuated; ſhe was then ordered two ſpoonfuls of a cordial anodyne mixture every ſecond hour: the vomiting now abated; the pulſe became ſmaller and more frequent; ſhe paſſed urine freely; but the pain and oppreſſed breathing increaſed. At ſeven P. M. her pulſe roſe to 142, and became weak and fluttering; ſhe called for bread, and ſwallowed a little with ſome difficulty; her drought was intense; the *dyſprœa* ſtill increaſed. She was now much oppreſſed, and began to tott; the pulſe ſunk and became imperceptible; ſhe complained of faintineſs, but on belching wind her breathing was relieved, and the pulſe returned, growing fuller and ſtronger: the pain of the ſide ſtill increaſing, 12 ounces of blood, very ſticky, were taken away; and two glyſters of warm water with oil were injected without effect: at 8 P. M. the pulſe became leſs frequent and ſmaller; ſhe complained much of the pain towards the ſcrobiculus cordis; her breathing was much oppreſſed; her belly was tenſe, and ſwelled as big as before the operation; her pulſe was now ſmall and feeble; ſhe looked ghaily; and expired a little after eight, 26 hours after the operation.

It is to be regretted that the relations would not permit the body to be opened.

Since the firſt certain accounts of the operation ſucceſsfully praſtiſed by a ſow-gelder on his own wife, in the beginning of the 16th century, there are on record above 70 well-attested hiſtories, wherein it has been ſucceſsfully performed: for, of all the caſes related by authors, it has not proved fatal to the patient above once in ten or nine inſtances; which evidently ſhews the propriety of the praſtice, and probability of ſucceſs, both in regard to the mother's own recovery, and for certainly preſerving the life of the child. But it ſhould never be attempted, excepting in thoſe caſes on-

ly where it is abſolutely impoſſible to deliver the woman by any other means whatever; for there are pelviſes to be met with, where, without having recourſe to this operation, both mother and child muſt inevitably periſh: ſuch have occurred to many praſtitioners, who, from want of reſolution, or from ill-founded prejudice, have allowed their patients to periſh from neglect, contrary to a well known maxim in phyſic, That in a deſperate caſe, it is better to employ a doubtful, and even deſperate remedy, than to abandon the patient to certain and utter ruin. Such, for inſtance, is a caſe related by Saviard, of a girl aged 27, whoſe ſtature was only three feet, who came to lie in at Paris, in the *Hotel Dieu*; every method but the operation was in vain attempted; both mother and child died. Mauriceau alſo relates the hiſtory of a woman who was left to die, where the aperture of the pelvis was ſo ſmall as not to admit the hand of the accoucheur. And, not to multiply inſtances, Mr De la Roche gives a caſe where the woman had been ſeven days in labour; the child was ſaved by the operation; but the woman died the fifth day after, probably from its being too long delayed: the diſtance, in this ſubject, from the lower vertebra lumborum and os pubis, was no more than two fingers breadth. The operation, when the neceſſity is evident, ought therefore to be early performed, that the patient, who from her make and conſtitution is generally delicate and puny may have every chance of recovery in her favour, without being exhauſted by the fruitleſs efforts of a tedious and painful labour, as too often has been the caſe. On theſe occaſions, the prudent accoucheur ſhould call in the advice of his elder brethren of the profeſſion, and, by his cautious and prudent conduct, avoid every cauſe of cenſure or reproach.

Exoſtoſes from the bones of the pelvis is a ſpecies of deformity very rarely met with in praſtice, and which ſeldom or never takes place to ſuch a degree as to render this operation neceſſary.

II. Conſtriction, calloſity, tumours, &c. about the vagina or os tinæ. The vagina and os tinæ are often affected with conſtrictions from cicatrices, with calloſities and tumours; but it is ſeldom, if ever, neceſſary to perform the Cæſarean ſection on this account. Tumours in the vagina many generally be removed with ſafety, even after the commencement of labour, and delivered happily ſucceed; or it may be ſometimes praſticeable for the accoucheur to paſs his hand by the ſide of the tumour, to turn the child, and deliver. With regard to conſtrictions in the vagina, and calloſities in the os uteri, there are many inſtances where, at the commencement of labour, it was impoſſible to introduce a finger into the vagina; yet the parts have dilated as labour increaſed, and the delivery terminated happily. At other times, the dilatation has begun during pregnancy, and been completed before delivery. There is a hiſtory, for inſtance, in the *Mém. de l'Acad. des Scienc.* 1712, of a woman whoſe vagina was no larger than to admit a common writing quill; ſhe had been married at 16, and conceived 11 years after: towards the fifth month of her pregnancy, the vagina began to dilate, and continued to do ſo till full time, when ſhe was ſafely delivered. Guilemeau dilated, and La Motte extirpated calloſities in the vagina and os tinæ, when the children were ſucceſsfully expelled.

expelled by the force of natural labour.

Harvey relates a case where the whole vagina was grown together with cicatrices; nature, after a tedious labour, made the dilatation, and a large child was born.

La Motte mentions his having delivered three women, who had not the smallest vestige of an orifice through the vagina to the uterus. Dr Simpson cut through a callosity of an os uteri which was half an inch thick, &c.

Upon the whole, tumours in the vagina, or about the orificium uteri, may be safely extirpated without danger of hemorrhagy or other fatal symptoms, and the delivery will happily succeed: and if the vagina be impervious, the os externum shut up, or the labia grown together, the parts should be opened with the scalpel, rather than risk an operation, at best in the issue doubtful and precarious; an operation never allowable in such cases, and therefore universally improper in distases or malconformation of the soft parts of generation. If the os externum be entirely closed, if the cavity of the vagina be entirely filled up, or the passage considerably obstructed by tumours, callosity, or constriction from cicatrice, and there is no reason to suspect a fault in the pelvis, of which a judgment may be formed by the common marks of deformity, under size, or a rickety habit; it is by such the best practice to open a passage through the vagina, and deliver the woman in the ordinary way. If there be no defect in the pelvis, the head of the child, or any other bulky part that prevents, will advance in this direction, till it meets with a resistance in the soft parts: thus the teguments will at length be protruded before the child's head, in form of a tumour, when a simple incision downwards to the perinæum, in the direction of the anus, will remove the cause of difficulty, by relieving the head; the child will afterwards safely pass, and the wound will heal without any bad consequence.

The state of the pelvis, and progress of the labour in these cases, may often be learned by the touch of the finger in ano.

III. Lacerated uterus is another cause for which this operation has been recommended. The uterus may be ruptured from violence in making the delivery; or such an accident may happen naturally, either from the cross presentation of the child in time of pregnancy, or in time of labour, when the pelvis is narrow: these cases are generally fatal; and it is very seldom, if ever, that the life of the mother can be saved by the Cæsarian section, after the fœtus escapes through the torn uterus into the cavity of the abdomen; because it often happens, that inflammation and sphæctus has affected the parts of the uterus that sustained the pressure previous to the rupture; or, if otherwise, convulsions or other fatal symptoms soon ensue, from the quantity of blood, waters, &c. poured into the cavity of the abdomen.

When the child cannot be extracted by the natural passages, tremours, singultus, cold sweats, syncope, and the death of the mother, for the most part, so quickly follow, that it will at least seem doubtful, to a prudent humane practitioner, how far it would be advisable, after so dreadful an accident, the woman apparently in the agonies of death, rashly to perform another dangerous operation, even with a view to preserve the

child, till he had waited till the mother recruits or expires.

If part of the child be contained within the uterus, and the feet can be reached, the practice is to deliver by the orifice of the womb: but when the whole fœtus has escaped entirely without the uterus, the Cæsarean operation is recommended as the only means of preserving both mother and child.

If the operation on this occasion be ever allowable, it may be asked,

1. At what time must it be performed?
2. Would it not have the appearance of inhumanity to have recourse to this expedient immediately after the uterus bursts, when the woman is seemingly ready to expire, although it be the only time when there is a chance of saving the child?
3. In most cases where this accident happens, should the Cæsarean section be made, is it not highly probable that the mother will survive so terrible a laceration?

4. For if it be done with a view to save the mother, in what manner is the extravasated blood, &c. to be evacuated from the cavity of the abdomen?

What seems to make cases of this kind unfavourable, when the accident happens in time of labour, is,

1<sup>mo</sup>, That here, the parts before rupture, in most cases, are in a gangrenous state.

2<sup>do</sup>, As the rupture is commonly towards the cervix, there is generally a much greater hemorrhagy by reason of the slow contraction of the uterus at this place.

3<sup>to</sup>, The uncertainty, whether, or how long, the patient will survive it, seems also a considerable obstacle to the operation under such disagreeable circumstances. *Ne occidisse videatur, quem fors interemit.*

IV. Ventral conceptions is a fourth indication for this operation. These are either in the ovaria, tubes, or cavity of the abdomen, and seldom arrive at great size; or are retained, very often a long time, without occasioning much complaint. The issue of these conceptions has also been no less various than extraordinary; for after being retained for a great many years in an indolent state, at length abscesses or ulcerations have formed, and they have been discharged through all the different parts of the abdomen.

Most women feel pain and violent motion at the time of ordinary delivery in these cases of ventral conception; if therefore the operation be ever necessary, now is the proper time to perform it. But in general, as the separation of extra-uterine fœtuses from their involucria, may occasion immediate death in many cases, from the vast hemorrhagy that might ensue from the non-contraction power of the parts to which they adhere; unless they point outwardly, or excite the most violent symptoms, they ought universally to be left to nature.

V. Hernia of the uterus are seldom or never sufficient to induce us to perform the Cæsarian section, as the uterus is very rarely influenced in such a manner, that the orifice cannot be reached, and the delivery successfully made. Many instances are to be found among surgical authors, where deliveries, under such circumstances, have been happily performed, without having recourse to so hazardous an expedient. Thus Mauriceau mentions a case, where the uterus, in a ventral hernia, was pushed along with the intestines above the

hernia

belly, and contained in a tumour of a prodigious size; the woman, however, was delivered at the end of her time, in the ordinary way. La Mott relates the history of a woman in a preternatural labour, whose uterus and child hung down pendulous to the middle of her thigh, but whom, notwithstanding, he safely delivered: and Ruysch gives a case where the midwife reduced the hernia before delivery; although it was proflapsed as far as the knee, the delivery was safely performed, and the woman had a good recovery.

Lastly, The position or bulk of the child.

Since the practice of turning the child and delivering by the feet, and the late improvement of obstetrical instruments, this operation is never to be performed on account of position, monstrosity, or any other obstacle on the part of the child.

Upon the whole, when the pelvis is faulty to such a degree, that no instrument can be conducted to tear and extract the child, this perhaps is the only case wherein this operation should be performed on the living subject. Incisions through the teguments of the abdomen to extract extra-uterine fetuses, or bones of fetuses, do not properly fall under the name of *Cæsarean section*, as that name implies incision of the uterus also.

When a woman advanced in pregnancy dies suddenly, either by accident or by natural disease, the Cæsarean section is recommended as an expedient to preserve the life of the child. This is a very proper measure, provided the death of the mother be ascertained; but sometimes it is a very nice and difficult point to distinguish between a deliquium and death; and therefore the accoucheur, on such an occasion, must act with the utmost circumspection. If the operation be delayed but a very short while after the mother expires, it will probably be in vain to make the attempt; for, whatever fabulous stories may be related to the contrary, there are few authentic cases of the fetus of any animal surviving the mother, perhaps an hour; and therefore every thing should be in readiness to extract the child with all possible expedition, after the event of the mother's death. But, in such cases, and the child is sometimes thrown off *in articulo mortis*; or the os uteri is so much dilated, that there is easy access to pass the hand, turn the child, and deliver. Thus one should be very cautious in having recourse to this operation, even in the above circumstances; which should never be done,

1. Till the death of the mother be ascertained beyond doubt;
2. Till the state of the os uteri be examined;
3. Till the consent of the relations be obtained; And,

Lastly, It need not be undertaken, except where the mother dies suddenly, between the 7th and 9th month.

It is unnecessary where the disease has been lingering; in such cases the child commonly dies before the mother.

When it is doubtful whether the child be alive or not, it may be determined by applying the hand on the abdomen of the mother about the time of, and for a little while after, her death, when the life of the child will be discovered by its motions and frug-

gling.

Thus having pointed out the different causes that determine this operation, it may be observed, that it is a frightful and hazardous one; and although performed successfully in a number of cases, yet, in many others, it has failed, and the woman has died either immediately or soon after. It should never, therefore, be undertaken but on extraordinary and desperate occasions; and then it is not only advisable, but incumbent on every practitioner to whom such cases occur.

To conclude, it may not be improper to give a few directions with regard to the method of performing the operation on the living subject.

Having emptied the bladder, and evacuated the contents of the intestines with repeated emollient glysters; the patient being encouraged, with proper cordials, and every other requisite in readiness, she must be placed on a table or bed, with her left side gently raised with pillows or bolsters, and properly secured by assistants. An incision must be made with a common convex scalpel, beginning rather below the navel at the middle space between it and the spine of the os ilium, carrying it obliquely forwards towards this bone, so that the wound in length may exceed six inches. This external wound is to be carried through the common teguments of the abdomen till the peritonæum is exposed, when the operator should rest a little, till the hæmorrhage be entirely abated. He must then, with great caution, make a small opening through this membrane, introduce his finger, and upon this a scalpel (which is preferable to scissars), and with great expedition make a complete dilatation; he must now wipe away the blood with a sponge, press the omentum or intestines gently to a side, if in the way, and endeavour to discover to what part of the uterus the placenta adheres, that it may be avoided in making the incision. This may easily be known by a thickness and solidity in the part, which distinguishes it from the rest of the uterus; it is still more easily discovered when the membranes are entire. The blood-vessels are less in number, and smallest in the middle and interior part of the uterus, which therefore, if the placenta does not interfere, is the proper place for making the incision, which must be performed with the utmost attention lest the child should be wounded: if the membranes are entire, more freedom may be used, and *vice versa*. The direction and length of the wound of the uterus must be the same with the external one. The child must now be quickly extracted, and the placenta carefully separated: these must be given to an assistant, who will divide the chord, and take care of the child, as the operator's attention must be wholly bestowed on the mother. The coagulated blood, &c. being removed by a sponge wrung out of warm water, (lest the uterus or intestines be protruded, which are very troublesome to reduce), the lips of the external wound must be quickly brought together, and retained by an assistant till secured by a few stitches; generally three will be sufficient: as many needles should be ready threaded with pretty large broad ligatures; the middle stitch ought to be made first; the needle should be introduced at a proper distance, i. e. about an inch and one-fourth from the side of the wound, carrying

it firſt from without inwards, and then from within outwards, ſecuring with a double ſlip a knot, to be ready to untie, leſt violent tenſion or inflammation ſhould enſue; under the knot a ſoft comprels of lint, ſharpee, or rolled plaſter, ſhould be applied, and the whole dreſſings muſt be ſecured by a proper comprels and bandage. The patient muſt be afterwards treated in the ſame manner as after lithotomy, or any other capital operation.

*Quæritur*, To what cauſe is the unſucceſsful event of this operation to be imputed? When the operation proves fatal, to what immediate cauſe are we to aſcribe the death of the patient? Is it nervous, or uterine irritation, from cutting, that kills? Is it internal hæmorrhage, or the extravafation of fluids into the cavity of the abdomen? Or are not the fatal conſequences rather to be imputed to the accels of the air on the irritable viſcera? This can only therefore be prevented by expoſing theſe parts for as ſhort a ſpace of time as poſſible. Dr Mouru, the preſent anatomical profeſſor at Edinburgh, in making experiments on young ſmall animals, ſuch as bitches, cats, frogs, &c. by opening the cavity of the abdomen, and tying the biliary ducts, remarks, that though a large opening into the abdomen be made by incifion, if the wound be quickly cloſed and ſitched, the animal will recover, and no bad conſequences follow; but if expoſed a few minutes to the air, dreadful pain ſoon comes on, which the creature expreſſes by the ſevereſt agonies; convuſions at laſt enſue, and death within four or ſix hours after the operation. On opening the abdomen after death, the whole viſcera are found to be in an inflamed ſtate, and univerſally adhering to one another. He has often repeated the experiment, and the ſame appearances as often take place.

May not the analogy here juſtly apply to the human ſubject? And, in performing the Cæſarean operation, ſhould we not be very careful that the viſcera be expoſed, as little as poſſible, and that the wound be covered with the utmoſt poſſible expedition?

The ill ſucceſs which generally attends the Cæſarean operation ſome years ago, induced ſome French practitioners to try a new method of extracting the child when, through the narrowneſs of the pelvis, or any other cauſe, it is impoſſible to deliver the woman either naturally or by means of inſtruments. This was by cutting the ſymphyſis of the os pubis; by which operation it was thought that the bones would ſeparate to a ſufficient degree to make room for the paſſage of the child. This operation is found not to be ſo fatal in itſelf as the Cæſarean ſectiõn; but unhappily it doth not promiſe with any certainty to afford the neceſſary relief to the woman. Dr V<sup>o</sup>ighan remarks, 1. That it is extremely difficult to execute it with a thick knife, however ſharp in the edge. The ligamentous and grifflly ſubſtance between the bones is ſo incomprefſible that it will hardly make room for the thicker part of the knife to follow its edge; but a thin knife goes through it with great eaſe.

2. Whoever has had a little practice, will find, that it may be executed without any danger of wounding the bladder or urethra; becauſe, in cutting cautiously with a thin knife, from above downwards and inwards, the inſtant that the whole is cut through,

there is both a particular ſound, which informs us that the buſineſs is done, and the two bones fly aſunder to a ſenſible diſtance.

3. When the ſymphyſis is completely divided, the oſſa pubis ſeparate ſo little a way, that ſome force is neceſſary to produce an interval of half an inch; and upon increaſing the force till the ſpace of interval comes to two inches and an half, there is a continued craſh, from the tearing of the ligamentous fibres at the poſterior joints, viz at the ſides of the ſacrum. This, though requiring great force, is eaſily affected, by bringing the thighs to right angles with the trunk of the body, and preſſing the knees gradually outwards and backwards. In that way, a ſmall force has a great effect, becauſe it has the advantage of a long lever, and is aſſiſted by almoſt the whole weight of the lower extremities.

4. When ſuch a violent ſeparation of the oſſa pubis has been produced, the ſacrum and oſſa innominata remain in contact only at their poſterior parts; the ligaments that connect them at the fore-part being all, more or leſs, torn aſunder.

5. The miſchief that may enſue upon cutting one joint of the pelvis, and tearing the other two aſunder, can be aſcertained by experience only. It is propoſed, that the incifion at the pubes ſhall not penetrate into the cavity of the abdomen. If, by accident, that ſhould happen, the operation would of courſe be very dangerous. Lacerations of tendons, ligaments, and ſleſhy parts, when not complicated with an external wound, generally heal up in a kindly manner, as we ſee in caſes of the ruptured tendo achillis, diſlocations, and fractures.

But, on the other hand, at the time of parturition, the body is remarkably diſpoſed to an inflammatory fever, which is always very dangerous when it riſes to any height; and therefore, whatever expoſes the body to conſiderable inflammation at that time, we may preſume, muſt be attended with ſome danger. And it muſt likewiſe be remembered, that women who are exceedingly crooked, are commonly ſo weak that they eaſily ſink under any great diſeaſe.

At the ſame time our author allows, that the Cæſarean ſectiõn, though it may ſave the child, yet will almoſt always be fatal to the mother. The cutting of the ſymphyſis, on the other hand, hath no probability of ſaving the child, and the effect on the mother muſt be doubtful. He indeed gives no inſtance of the bad ſucceſs of the cutting the ſymphyſis, though he gives an additional one of the fatality of the Cæſarean operation. As a deciſive proof of the inefficacy of the cutting the ſymphyſis to ſave the child, he gives the figures of the diſtorted pelvis of two women; by which it appears, that the utmoſt dilatation uſed by this means could have amounted to no more than to enlarge the paſſage to a circle of two inches and a quarter, which is not at all ſufficient to afford an exit to a living child. In all caſes therefore, when the mother cannot be delivered without deſtroying the child, he gives the preference to the crotchet; after the uſe of which, he ſays, if the operation is ſlowly performed, by allowing intervals of eaſe, as in the natural labour, women recover almoſt as ſoon as in other caſes. Yet, notwithstanding all that can be argued againſt this operation, it is plain, that as it

gives



gives a probable chance of saving the mother's life, though at the expence of the child, it ought always to be preferred to the Cæſarean ſection, which ſaves the child, but deſtroys the mother. Nevertheless, it would be ſhocking to think of performing even this operation where there was a poſſibility of accompliſhing the delivery by any other means.

CHAP. XVI. *Of the Management of Women after delivery.*

THE woman being delivered of the child and placenta, let a ſoft linnen-cloth, warmed, be applied to the external parts; and if ſhe complains much of a ſmarting ſoreneſs, ſome pomatum may be ſpread upon it. The linnen that was laid below her, to ſponge up the diſcharges, muſt be removed, and replaced with others that are clean, dry, and warm. Let her lie on her back, with her legs extended cloſe to each other; or upon her ſide, if ſhe thinks ſhe can lie eaſier in that poſition, until ſhe recovers from the fatigue: if ſhe is ſpent and exhausted, let her take a little warm wine or caudle, or, according to the common cuſtom, ſome nutmeg and ſugar grated together in a ſpoon: the principal deſign of adminiſtering this powder, which among the good women is ſeldom neglected, is to ſupply the want of ſome cordial draught, when the patient is too weak to be raiſed, or ſuppoſed to be in danger of retchings from her ſtomach's being overloaded. When ſhe hath in ſome meaſure recovered her ſtrength and ſpirits, let the cloths be removed from the parts, and others applied in their room; and, if there is a large diſcharge from the uterus, let the wet linnen below her be alſo ſhifted, that ſhe may not run the riſk of catching cold.

When the patient is either weak or faintiſh, ſhe ought not to be taken out of bed, or even raiſed up to have her head and body ſhifted, until ſhe is a little recruited; otherwiſe ſhe will be in danger of repeated faintings, attended with convulſions, which ſometimes end in death. To prevent theſe bad conſequences, her ſkirt and petticoats ought to be looſened and pulled down over the legs, and replaced by another well warmed, with a broad head-band to be ſlipped in below, and brought up over her thighs and hips: a warm double cloth muſt be laid on the belly, which is to be ſurrounded by the head-band of the ſkirt pinned moderately tight over the cloth, in order to compreſs the viſcera and the relaxed parietes of the abdomen, more or leſs, as the woman can eaſily bear it; by which means the uterus is kept firm in the lower part of the abdomen, and prevented from rolling from ſide to ſide when the patient is turned: but the principal end of this compreſſion is to hinder too great a quantity of blood from ruſhing into the relaxed veſſels of the abdominal contents, eſpecially when the uterus is emptied all of a ſudden by a quick delivery. The preſſure being thus ſuddenly removed, the head is all at once robbed of its proportion of blood, and the immediate reſultion precipitates the patient into dangerous lypothymia.

For this reaſon the belly ought to be firmly compreſſed by the hands of an aſſiſtant, until the bandage is applied; or, in lieu of it, a long towel, ſheet, or roller, to make a ſuitable compreſſion: but for this

purpose different methods are uſed in different countries, or according to the different circumſtances of the patients. The head-cloaths and ſhift ought alſo to be changed, becauſe with ſweating in time of labour they are rendered wet and diſagreeable. Several other applications are neceſſary, when the external or internal parts are rent or inflamed, miſfortunes that ſometimes happen in laborious and preternatural caſes.—We ſhall conclude this chapter with giving ſome neceſſary directions with regard to air, diet, &c.

Although we cannot remove the patient immediately after delivery into another climate, we can qualify the air ſo as to keep it in a moderate and ſalutary temper, by rendering it warm or cold, moiſt or dry, according to the circumſtances of the occaſion. With regard to diet, women, in time of labour, and even till the ninth day after delivery, ought to eat little ſolid food, and none at all during the firſt five or ſeven: let them drink plentifully of warm diluting fluids, ſuch as barley-water, gruel, chicken-water, and tea; caudles are alſo commonly uſed, compoſed of water-gruel boiled up with mace and cinnamon, to which, when ſtrained, is added a third or fourth part of white wine, or leſs, if the patient drinks plentifully, ſweetened with ſugar to their taſte: this compoſition is termed *white caudle*; whereas, if ale is uſed inſtead of wine, it goes under the name of *brown caudle*. In ſome countries, eggs are added to both kinds; but, in that caſe, the woman is not permitted to eat meat or broths till after the fifth or ſeventh day: in this country, however, as eggs are no part of the ingredients, the patient is indulged with weak broth ſooner, and ſometimes allowed to eat a little boiled chicken. But all theſe different preparations are to be preferred weaker or ſtronger, with regard to the ſpices, wine, or ale, according to the different conſtitutions and ſituations of different patients: for example, if ſhe is low and weak, in conſequence of an extraordinary diſcharge of any kind, either before or after delivery, or if the weather is cold, the caudles and broths may be made the ſtronger; but if ſhe is of a full habit of body, and has the leaſt tendency to a fever, or if the ſeaſon is exceſſively hot, theſe drinks ought to be of a very weak conſiſtence, or the patient reſtricted to gruel, tea, barley and chicken water, and theſe varied according to the emergency of the caſe.

Her food muſt be light and eaſy of digeſtion, ſuch as panada, bifeuit, and ſago; about the fifth or ſeventh day ſhe may eat a little boiled chicken, or the lighteſt kind of young meat; but theſe laſt may be given ſooner or later, according to the circumſtances of the caſe and the appetite of the patient. In the regimen as to the eating and drinking, we ſhould rather err on the abſtemious ſide than indulge the woman with meat and ſtrong fermented liquors, even if theſe laſt ſhould be moſt agreeable to her palate: for we find by experience, that they are apt to increaſe or bring on fevers, and that the moſt nouriſhing and ſalutary diet is that which we have above preſcribed. Every thing that is difficult of digeſtion, or quickens the circulating fluids, muſt of neceſſity promote a fever; by which the neceſſary diſcharges are obſtructed, and the patient's life endangered.

As to the article of sleeping and watching, the patient: must be kept as free from noise as possible, by covering the floors and flairs with carpets and cloths, oiling the hinges of the doors, silencing the bells, tying up the knockers, and in noisy streets throwing the pavement with straw; if, notwithstanding these precautions, she is disturbed, her ears must be stuffed with cotton, and opiates administered to procure sleep; because watching makes her restless, prevents perspiration, and promotes a fever.

Motion and rest are another part of the nonnatural to which we ought to pay particular regard. By tossing about, getting out of bed, or sitting up too long, the perspiration is discouraged and interrupted; and in this last attitude the uterus, not yet fully contracted, hangs down, stretching the ligaments, occasioning pain, cold shiverings, and a fever: for the prevention of these bad symptoms, the patient must be kept quiet in bed till after the fourth or fifth day, and then be gently lifted up in the bed-cloaths, in a lying posture, until the bed can be adjusted, into which she must be immediately reconveyed, there to continue, for the most part, till the ninth day, after which period women are not so subject to fevers as immediately after delivery. Some there are who, from the nature of their constitutions, or other accidents, recover more slowly; and such are to be treated with the same caution after as before the ninth day, as the case seems to indicate: others get up, walk about, and recover, in a much shorter time; but these may some time or other pay dearly for their foolhardiness, by encouraging dangerous fevers: so that we ought rather to err on the safe side than run any risk whatever.

What next comes under consideration is the circumstance of retention and excretion. We have formerly observed, that, in time of labour, before the head of the child is locked into the pelvis, if the woman has not had an easy passage in her belly that same day, the rectum and colon ought to be emptied by a glyster, which will assist the labour, prevent the disagreeable excretion of the feces before the child's head, and enable the patient to remain two or three days after, without the necessity of going to stool. However, should this precaution be neglected, and the patient very colic after delivery, we must beware of throwing up stimulating glysters, or administering strong cathartics, lest they should bring on too many loose stools, which, if they cannot be stopped, sometimes produce fatal consequences, by obstructing the perspiration and lochia, and exhausting the woman, so as that she will die all of a sudden; a catastrophe which hath frequently happened from this practice. Wherefore, if it be necessary to empty the intestines, we ought to prescribe nothing but emollient glysters, or some very gentle opener, such as manna, or *elect. lenitivum*. But no excretion is of more consequence to the patient's recovery than a free perspiration; which is so absolutely necessary, that unless she has a moisture continually on the surface of her body, for some days after the birth, she seldom recovers to advantage: her health, therefore, in a great measure, depends upon her enjoying undisturbed repose, and a constant breathing sweat, which prevents a fever, by carrying off the tension, and assists the equal discharge of the lochia: and when

these are obstructed, and a fever ensues with pain and restlessness, nothing relieves the patient so effectually as rest and profuse sweating, procured by opiates and sudorifics at the beginning of the complaints; yet these last must be more cautiously prescribed in excessive hot than in cool weather.

The last of the nonnaturals to be considered are the passions of the mind, which also require particular attention. The patient's imagination must not be disturbed by the news of any extraordinary accident which may have happened to her family or friends: for such information hath been known to carry off the labours entirely, after they were begun, and the woman has sunk under her dejection of spirits: and, even after delivery, these unreasonable communications have produced such axiety as obstructed all the necessary excretions, and brought on a violent fever and convulsions, that ended in death.

#### CHAP. XVII. *Of violent Floodings.*

ALL women, when the placenta separates, and after it is delivered, lose more or less red blood, from the quantity of half a pound to that of one pound, or even two; but should it exceed this proportion, and continue to flow without diminution, the patient is in great danger of her life: this hazardous hemorrhage is known by the violence of the discharge, wetting fresh cloaths as fast as they can be applied; from the pulse becoming low and weak, and the countenance turning pale; then the extremities grow cold, she sinks into faintings, and, if the discharge is not speedily stopped or diminished, is seized with convulsions, which often terminate in death.

This dangerous efflux is occasioned by every thing that hinders the emptied uterus from contracting, such as great weakness and lassitude, in consequence of repeated floodings before delivery; the sudden evacuation of the uterus; sometimes, though seldom, it proceeds from part of the placenta's being left in the womb; it may happen when there is another child, or more, still undelivered; when the womb is kept distended with a large quantity of coagulated blood; or when it is inverted by pulling too forcibly at the placenta.

In this case, as there is no time to be lost, and internal medicines cannot act so suddenly as to answer the purpose, we must have immediate recourse to external application. If the disorder be owing to weakness, by which the uterus is disabled from contracting itself, so that the mouths of the vessels are left open; or, though contracted a little, yet not enough to restrain the hemorrhage of the thin blood; or if, in separating the placenta, the accoucher has scratched or tore the inner surface or membrane of the womb; in these cases, such things must be used as will assist the contractile power of the uterus, and hinder the blood from flowing too fast into it and the neighbouring vessels; for this purpose, cloths dipped in any cold astringent fluid, such as oxycerate, or red tart wine, may be applied to the back and belly. Some prescribe venesection in the arm, to the amount of five or six ounces, with a view of making revulsion: if the pulse is strong, this may be proper; otherwise, it will do more harm than good. Others order ligatures, for compressing the returning veins at the haams, arms,

and

*After-pains* and neck, to retain as much blood as possible in the extremities and head. Besides these applications, the vagina may be filled with tow or linens, dipped in the above-mentioned liquors, in which a little alum, or *sachar-jardini* hath been dissolved: nay, some practitioners inject *proof-spirits* warmed, or, fusing them up in a rag or sponge, introduce and squeeze them into the uterus, in order to constrict the vessels.

If the flooding proceeds from another child, the retention of the placenta, or coagulated blood, these ought immediately to be extracted; and if there is an inversion of the uterus, it must be speedily reduced. Should the hæmorrhage, by these methods, abate a little, but still continue to flow, though not in such a quantity as to bring on sudden death, some red wine and jelly ought to be prescribed for the patient, who should take it frequently, and a little at a time; but above all things chicken or mutton broths, administered in the same manner, for fear of overloading the weakened stomach, and occasioning retchings: these repeated in small quantities, will gradually fill the exhausted vessels, and keep up the circulation. If the pulse continues strong, it will be proper to order repeated draughts of barley-water, acidulated with elixir vitriol: but if the circulation be weak and languid, extract of the bark, dissolved in *aq. cinnamon tenuis*, and given in small draughts, or exhibited in any other form, will be serviceable; at the same time, lulling the patient to rest with opiates. These, indeed, when the first violence of the flood is abated, if properly and cautiously used, are generally more effectual than any other medicine.

#### CHAP. XVIII. *Of the After-pains.*

*AFTER-PAINS* commonly happen when the fibrous part of the blood is retained in the uterus or vagina, and formed into large clots, which are detained by the sudden contraction of the os internum and externum, after the placenta is delivered: or, if these should be extracted, others will sometimes be formed, tho' not so large as the first, because the cavity of the womb is continually diminishing after the birth. The uterus, in contracting, presses down these coagulums to the os internum; which being again gradually stretched, produces a degree of labour-pains, owing to the irritation of its nerves: in consequence of this uneasiness, the woman squeezes the womb as in real labour; the force being increased, the clots are pushed along, and when they are delivered she grows easy. The larger the quantity is of the coagulated blood, the feverer are the pains, and the longer they continue.

Women in the first child seldom have after-pains; because, after delivery, the womb is supposed to contract; and push off the clots with greater force in the first than in the following labours: after-pains may also proceed from obstructions in the vessels, and irritations at the os internum. In order to prevent or remove these pains, as soon as the placenta is separated and delivered, the hand being introduced into the uterus, may clear it of all the coagula. When the womb is felt through the parietes of the abdomen larger than usual, it may be taken for granted that there is either another child, or a large quantity of this clotted blood; and, which soever it may be, there is a

necessity for its being extracted. If the placenta comes away of itself, and the after-pains are violent, they may be alleviated and carried off by an opiate: for, by sleeping and sweating plentifully, the irritation is removed, the evacuations are increased, the os uteri is insensibly relaxed, and the coagula slide easily along. When the discharge of the lochia is small, the after-pains, if moderate, ought not to be restrained; because the squeezing which they occasion promotes the other evacuation, which is necessary for the recovery of the patient. After-pains may also proceed from an obstruction in some of the vessels, occasioning a small inflammation of the os internum and ligaments; and the squeezing thereby occasioned may not only help to propel the obstructing fluid, but also (if not too violent) contribute to the natural discharge.

#### CHAP. XIX. *Of the Lochia.*

We have already observed, that the delivery of the child and placenta is followed by an efflux of more or less blood, discharged from the uterus, which, by the immediate evacuation of the large vessels, is allowed to contract itself the more freely, without the danger of an inflammation, which would probably happen in the contraction, if the great vessels were not emptied at the same time: but as the fluids in the smaller vessels cannot be so soon evacuated, or returned into the vena cava, it is necessary that, after the great discharge is abated, a slow and gradual evacuation should continue, until the womb shall be contracted to near the same size which it had before pregnancy; and to this it attains about the 18th or 20th day after delivery, though the period is different in different women.

When the large vessels are emptied immediately after delivery, the discharge frequently ceases for several hours, until the fluids in the smaller vessels are propelled into the larger, and then begins to flow again, of a paler colour.

The red colour of the lochia commonly continues till the fifth day, though it is always turning more and more ferous from the beginning: but, about the fifth day, it flows off a clear, or sometimes (though seldom) of a greenish tint; for, the mouths of the vessels growing gradually narrower by the contraction of the uterus, at last allow the ferous part only to pass: as for the greenish hue, it is supposed to proceed from a dissolution of the cellular or cribriform membrane or mucus, that surrounded the surface of the placenta and chorion; part of which, being left in the uterus, becomes livid, decays, and, dissolving, mixes with and tinctures the discharge as it passes along.

Though the lochia, as we have already observed, commonly continue till the 18th or 20th day, they are every day diminishing in quantity, and soonest cease in those women who suckle their children, or have had an extraordinary discharge at first; but the colour, quantity, and duration, differ in different women: in some patients, the red colour disappears on the first or second day; and in others, though rarely, it continues more or less to the end of the month: the evacuation in some is very small, in others excessive: in one woman it ceases very soon, in another flows during

during the whole month: yet all of these patients shall do well.

Some allege, that this discharge from the uterus is the same with that from a wound of a large surface; but it is more reasonable to suppose, that the change of colour and diminution of quantity proceed from the slow contraction of the vessels; because, previous to pus, there must have been lacerations and impotheses, and, in women who have suddenly died after delivery, no wound or excoriation hath appeared upon the inner surface of the womb, which is sometimes found altogether smooth, and at other times rough and unequal, on that part to which the placenta adhered. The space that is occupied before the delivery, from being six inches in diameter, or 18 inches in circumference, will, soon after the birth, be contracted to one third or fourth of these dimensions.

#### CHAP. XX. *Of the Milk-fever.*

ABOUT the fourth day, the breasts generally begin to grow turgid and painful. We have formerly observed, that, during the time of uterine gestation, the breasts in most women gradually increase till the delivery, growing softer as they are enlarged by the vessels being more and more filled with fluids; and by this gradual distension they are prepared for secreting the milk from the blood after delivery. During the two or three first days after parturition, especially when the woman has undergone a large discharge, the breasts have been sometimes observed to subside and grow flaccid; and about the 3d or 4th day, when the lochia begin to decrease, the breasts swell again to their former size, and stretch more and more, until the milk, being secreted, is either sucked by the child, or frequently of itself runs out at the nipples.

Most of the complaints incident to women after delivery, proceed either from the obstruction of the lochia in the uterus, or of the milk in the breasts, occasioned by any thing that will produce a fever; such as catching cold, long and severe labour, eating food that is hard of digestion, and drinking fluids that quicken the circulation of the blood in the large vessels; by which means the smaller, with all the secretory and excretory ducts, are obstructed.

The discharge of the lochia being so different in women of different constitutions, and besides in some measure depending upon the method of management, and the way of life peculiar to the patient, we are not to judge of her situation from the colour, quantity, and duration of them, but from the other symptoms that attend the discharge; and if the woman seems hearty, and in a fair way of recovery, nothing ought to be done with a view to augment or diminish the evacuation. If the discharge be greater than she can bear, it will be attended with all the symptoms of inanition; but as the lochia seldom flow so violently as to destroy the patient of a sudden, she may be supported by a proper nourishing diet, assisted with cordial and restorative medicines. Let her, for example, use broths, jellies, and asses milk; if the pulse is languid and sunk, she may take repeated doses of the *confect. cardiac.* with mixtures composed of the cordial waters and volatile spirits: subastringents and opiates

frequently administered, with the *cort. Peruvian.* in different forms, and auftere wines, are of great service. On the other hand, when the discharge is too small, or hath ceased altogether, the symptoms are more dangerous, and require the contrary method of cure: for now the business is to remove a too great plentitude of the vessels in and about the uterus, occasioning tension, pain, and labour, in the circulating fluids; from whence proceed great heat in the part, restlessness, fever, a full, hard, quick pulse, pains in the head and back, nausea, and difficulty in breathing. These complaints, if not at first prevented, or removed by rest and plentiful sweating, must be treated with venesection and the antiphlogistic method.

When the obstruction is recent, let the patient lie quiet, and encourage a plentiful diaphoresis, by drinking frequently of warm, weak, diluting fluids, such as water-gruel, barley-water, tea, or weak chicken-broth.

Should these methods be used without success, and the patient, far from being relieved by rest, plentiful sweating, or a sufficient discharge of the obstructed lochia, labour under an hot, dry skin, anxiety, and a quick, hard, and full pulse, the warm diaphoretics must be laid aside; because, if they fail of having the desired effect, they must necessarily increase the fever and obstruction, and recourse be had to bleeding at the arm or ankle to more or less quantity, according to the degree of fever and obstruction; and this evacuation must be repeated as there is occasion. When the obstruction is not total, it is supposed more proper to bleed at the ankle than at the arm; and at this last, when the discharge is altogether stopped, her ordinary drink ought to be impregnated with nitre.

If she is colicive, emollient and gently opening glysters may be occasionally injected; and her breasts must be fomented and sucked, either by the mouth or pipe-glasses. If by these means the fever is abated; and the necessary discharges return, the patient commonly recovers; but if the complaints continue, the antiphlogistic method must still be pursued. If, notwithstanding these efforts, the fever is not diminished or removed by a plentiful discharge of the lochia from the uterus, the milk from the breasts, or by a critical evacuation by sweat, urine, or stool, and the woman is every now and then attacked with cold shiverings; an abscess or abscesses will probably be formed in the uterus or neighbouring parts, or in the breasts; and sometimes the matter will be translated to other situations, and the seat of it foretold from the part's being affected with violent pains: these abscesses are more or less dangerous, according to the place in which they happen, the largeness of the suppuration, and the good or bad constitution of the patient.

If, when the pains in the epigastric region is violent, and the fever increased to a very high degree, the patient should all of a sudden enjoy a cessation from pain, without any previous discharge or critical eruption, the physician may pronounce that a mortification is begun; especially if, at the same time, the pulse becomes low, quick, wavering, and intermitting; if the woman's countenance, from being florid, turns dusky and pale, while she herself, and all the attendants, conceive her much mended; in that case, she will grow delirious,

Milk-fever. rious, and die in a very short time.

What we have said on this subject regards that fever which proceeds from the obstructed lochia, and in which the breasts may likewise be affected: but the milk-fever is that in which the breasts are originally concerned, and which may happen tho' the lochia continue to flow in sufficient quantity; nevertheless, they mutually promote each other, and both are to be treated in the manner already explained; namely, by opiates, diluents, and diaphoretics, in the beginning; and, these prescriptions failing, the obstructions must be relieved by the antiphlogistic method described above. The milk-fever alone, when the uterus is not concerned, is not so dangerous, and much more easily relieved. Women of a healthy constitution, who suckle their own children, have good nipples, and whose milk comes freely, are seldom or never subject to this disorder, which is more incident to those who do not give suck, and neglect to prevent the secretion in time; or, when the milk is secreted, take no measures for emptying their breasts. This fever likewise happens to women who try too soon to suckle, and continue their efforts too long at one time; by which means the nipples, and consequently the breasts, are often inflamed, swelled, and obstructed.

In order to prevent a too great turgency in the vessels of the breasts, and the secretion of milk, in those women who do not choose to suckle, it will be proper to make external application of those things which, by their pressure and repercussive force, will hinder the blood from flowing in too great quantity to this part, which is now more yielding than at any other time: for this purpose, let the breasts be covered with *emp. de minia*, *diapalma*, or *emp. simp.* spread upon linen, or cloths dipped in camphorated spirits, be frequently applied to these parts and the axill-pits; while the patient's diet and drink is of the lightest kind, and given in small quantities. Notwithstanding these precautions, a turgency commonly begins about the third day; but by rest, moderate sweating, and the use of these applications, the tension and pain will subside about the fifth or sixth day, especially if the milk runs out at the nipples: but if the woman catches cold, or is of a full habit of body, and not very abstemious, the tension and pain increasing, will bring on a cold shivering succeeded by a fever; which may obstruct the other excretions, as well as those of the breast.

In this case, the sudorifics above recommended must be prescribed; and if a plentiful sweat ensues, the patient will be relieved; at the same time the milk must be extracted from her breasts, by sucking with the mouth or glasses: should these methods fail, and the fever increase, she ought to be bled in the arm; and instead of the external applications hitherto used, emollient liniments and cataplasms must be substituted, in order to soften and relax. If, in spite of these endeavours, the fever proceeds for some days, the patient is frequently relieved by critical sweats, a large discharge from the uterus, milary eruptions, or loeic stools mixed with milk, which is curdled in the intestines; but should none of these evacuations happen, and the inflammation continue with increasing violence, there is danger of an imposthume, which is to be brought to maturity, and managed like other inflam-

matory tumours; and no astringents ought to be applied, lest they should produce scirrhus swellings in the glands.

As the crisis of this fever, as well as of that last described, often consists in milary eruptions over the whole surface of the body, but particularly on the neck and breast, by which the fever is carried off, nothing ought to be given which will either greatly increase or diminish the circulating force, but such only as will keep out the eruptions. But if, notwithstanding these eruptions, the fever, instead of abating, is augmented, it will be necessary to diminish its force, and prevent its increase, by those evacuations we have mentioned above. On the contrary, should the pulse sink, the eruptions begin to retreat inwardly, and the morbid matter be in danger of falling upon the viscera, we must endeavour to keep them out by opiates and sudorific medicines; and here blisters may be applied with success.

#### CHAP. XXI. Of the Evacuations necessary at the end of the Month after Delivery.

Those who have had a sufficient discharge of the lochia, plenty of milk, and suckle their own children, commonly recover with ease, and, as the superfluous fluids of the body are drained off at the nipples, seldom require evacuations at the end of the month; but if there are any complaints from fullness, such as pains and itches, after the 20th day, some blood ought to be taken from the arm, and the belly gently opened by frequent glysters, or repeated doses of laxative medicines.

If the patient has tolerably recovered, the milk having been at first sucked or discharged from the nipples, and afterwards discussed, no evacuations are necessary before the third or fourth week; and sometimes not till after the first flowing of the menses, which commonly happens about the fifth week; if they do not appear within that time, gentle evacuations must be prescribed, to carry off the plethora, and bring down the catamenia.

#### EXPLANATION of the PLATES.

Fig. 1. gives a front-view of the uterus *in situ* Plate  
suspended in the vagina; the anterior parts of ossa CLXXXVIIII  
ischium, with the ossa pubis; pudenda, perineum,  
and anus, being removed in order to shew the internal parts.

A, the last vertebra of the loins.

BB, the ossa ilium.

CC, the acetabula.

DD, the inferior and posterior parts of the ossa ischium.

E, the part covering the extremity of the coccyx.

F, the inferior part of the rectum.

GG, the vagina cut open longitudinally, and stretched on each side of the collum uteri, to shew in that manner the uterus is suspended in the same.

HH, part of the vesica urinaria stretched on each side of the vagina, and inferior part of the fundus uteri.

I, the collum uteri.

K, the fundus uteri.

LL, the tubi Fallopiiani and fimbriae.

MM, the ovaria.

NN, the

NN, the ligamenta lata and rotunda.

OO, the superior part of the rectum.

Fig. 2. gives a front-view of the uterus in the beginning of the first month of pregnancy; the anterior part being removed that the embryo might appear through the amnios, the chorion being dissected off.

A, the fundus uteri.

B, the collum uteri, with a view of the rugous canal that leads to the cavity of the fundus.

C, the os uteri.

Fig. 3. In the same view and section of the parts as in fig. 1. shews the uterus as it appears in the second or third month of pregnancy.

F, the anus.

G, the vagina, with its plicæ.

HH, the posterior and inferior part of the urinary bladder extended on each side; the anterior and superior part being removed.

II, the mouth and neck of the womb, as raised up when examining the same by the touch, with one of the fingers in the vagina.

KK, the uterus as stretched in the second or third month, containing the embryo, with the placenta adhering to the fundus.

Fig. 4. In the same view and section of the parts with the former figures, represents the uterus in the eighth or ninth month of pregnancy.

A, the uterus as stretched to near its full extent, with the waters, and containing the fœtus entangled in the funis, the head presenting at the upper part of the pelvis.

BB, the superior part of the ossa ilium.

CC, the acetabula.

DD, the remaining posterior parts of the ossa ischium.

E, the coccyx.

F, the inferior part of the rectum.

GGG, the vagina stretched on each side.

H, the os uteri, the neck being stretched to its full extent or entirely obliterated.

II, part of the vesica urinaria.

KK, the placenta, at the superior and posterior part of the uterus.

LL, the membranæ.

M, the funis umbilicalis.

Fig. 5. gives a front view of twins *in utero* in the beginning of labour.

A, the uterus as stretched, with the membranæ and waters.

BB, the superior parts of the ossa ilium.

CC, the acetabula.

DD, the ossa ischium.

E, the coccyx.

F, the lower part of the rectum.

GG, the vagina.

H, the os internum stretched open about a finger-breadth, with the membranæ and waters in time of labour-pains.

II, The inferior part of the uterus, stretched with the waters which are below the head of the child that presents.

KK, the two placentas adhering to the posterior part of the uterus, the two fœtuses lying before them, one with its head in a proper position at the inferior part of the uterus, and the other situated preternaturally

with the head to the fundus: the bodies of each are here entangled in their proper funis, which frequently happens in the natural as well as preternatural positions.

LLL, the membranæ belonging to each placenta.

Fig. 6. shews, in a lateral view and longitudinal division of the parts, the gravid uterus when labour is somewhat advanced.

A, the lowest vertebra of the back; the distance from which to the last-mentioned vertebra is here shewn by dotted lines.

CC, the usual thickness and figure of the uterus when extended by the waters at the latter end of pregnancy.

D, the same contracted and grown thicker after the waters are evacuated.

EE, the figure of the uterus when pendulous.

FF, the figure of the uterus when stretched higher than usual, which generally occasions vomitings and difficulty of breathing.

G, the os pubis of the left side.

HH, the os internum.

I, the vagina.

K, the left nympha.

L, the labium pudendi of the same side.

M, The remaining portion of the bladder.

N, the anus.

OP, the left hip and thigh.

Fig. 7. shews the forehead of the fœtus turned backwards to the os sacrum, and the occiput below the pubes, by which means the narrow part of the head is to the narrow part of the pelvis, that is, between the inferior parts of the ossa ischium.

A, the uterus contracted closely to the fœtus after the waters are evacuated.

BCD, the vertebræ of the loins, os sacrum, and coccyx.

E, the anus.

F, the left hip.

G, the perinæum.

H, the os externum beginning to dilate.

I, the os pubis of the left side.

K, the remaining portion of the bladder.

L, the posterior part of the os uteri.

Fig. 8. is principally intended to shew in what manner the perinæum and external parts are stretched by the head of the fœtus, in a first pregnancy, towards the end of the labour.

A, the abdomen.

B, the labia pudendi.

C, the clitoris and its preputium.

D, the hairy scalp of the fœtus, swelled at the vertex, in a laborious case, and protruded to the os externum.

E, F, the perinæum and anus pushed out by the head of the fœtus in form of a large tumour.

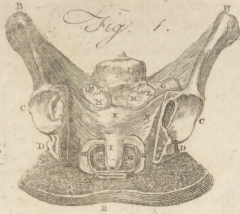
GG, the parts that cover the tuberosities of the ossa ischium.

H, the part that covers the os coccygis.

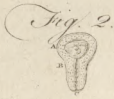
Fig. 9. shews in what manner the head of the fœtus is helped along with the forceps, as artificial hands, when it is necessary for the safety of either mother or child.

AABC, the vertebræ of the loins, os sacrum, and coccyx.

D, the



*Fig. 1.*



*Fig. 2.*

*Fig. 4.*

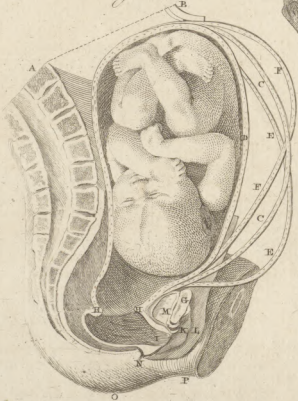


*Fig. 3.*

*Fig. 5.*



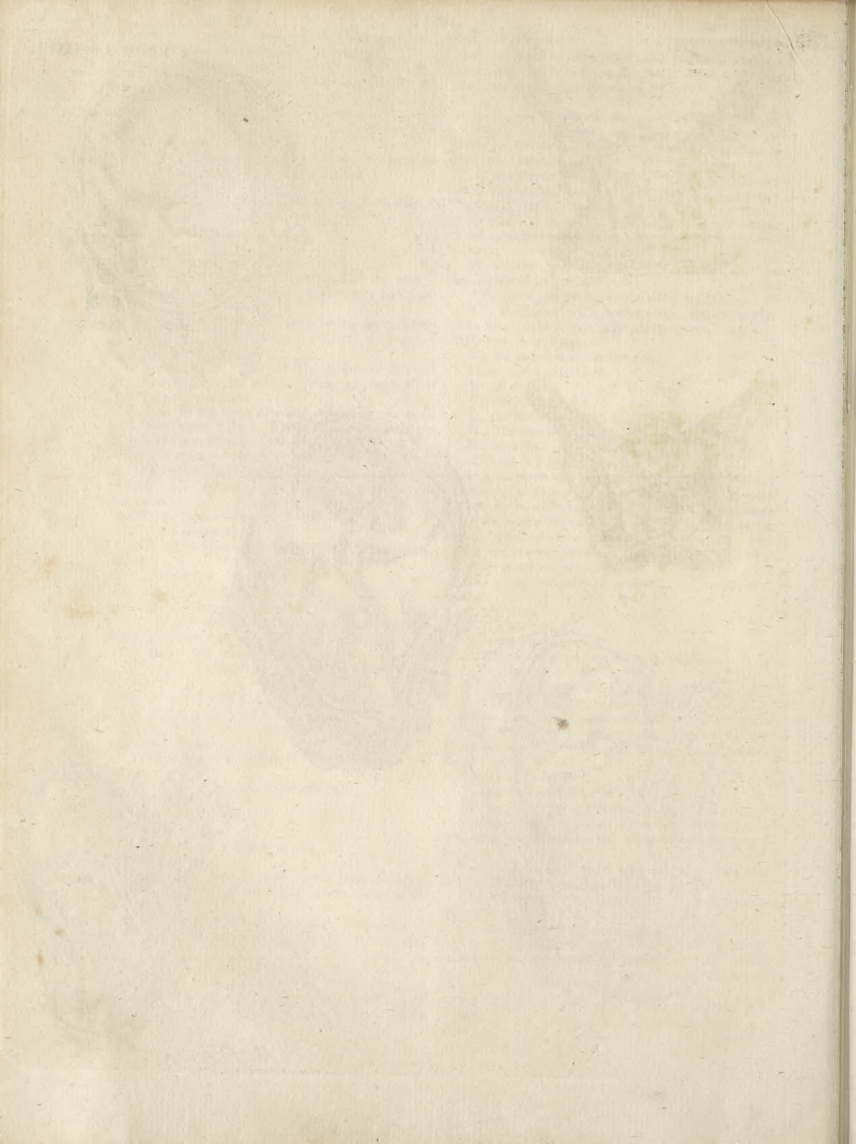
*Fig. 6.*



*Fig. 7.*

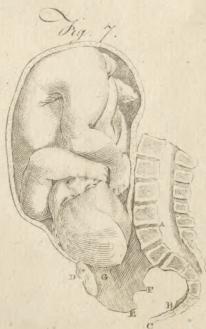
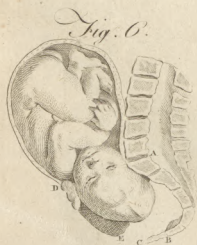
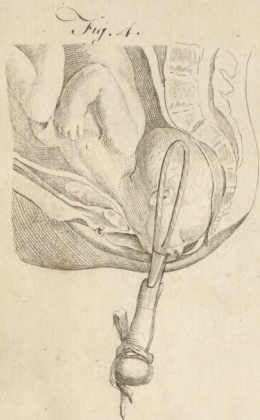
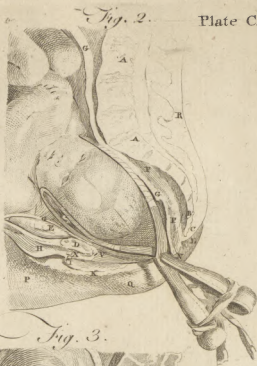
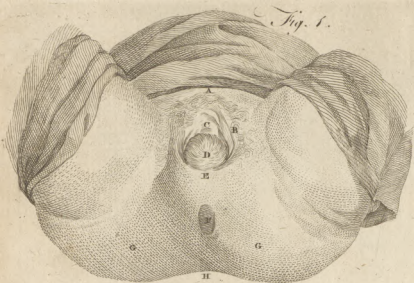


*A Bell Sculp.*









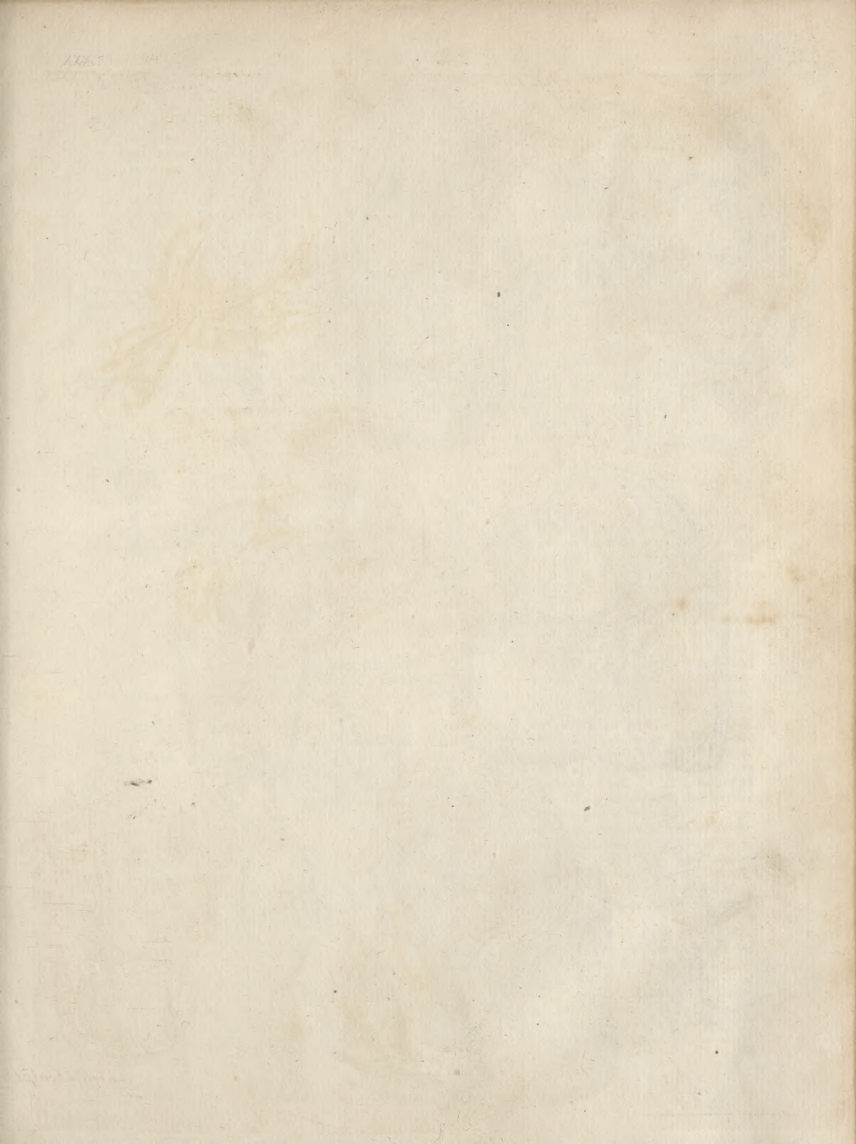


Fig. 1.

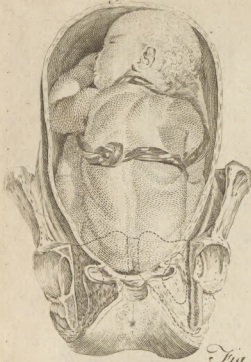


Fig. 2.



Fig. 6.

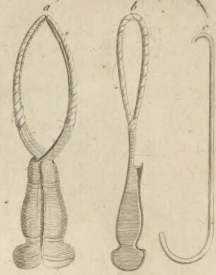


Fig. 3.



Fig. 7.

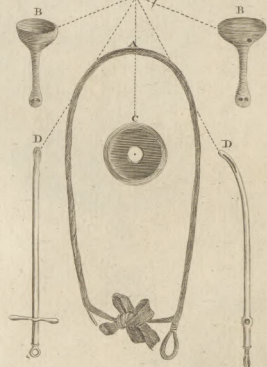


Fig. 5.



Fig. 4.

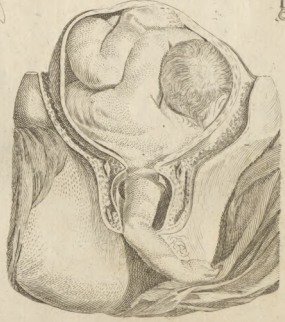
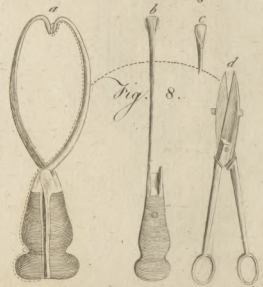


Fig. 8.



Explanat. D, the os pubis of the left side.  
 of E, the remaining part of the bladder.  
 Plates. FF, the intestinum rectum.  
 GGG, the uterus.  
 H, the mons veneris.  
 I, the clitoris, with the left nymph.  
 X, the corpus cavernosum clitoridis.  
 V, the meatus urinarius.  
 K, the left labium pudendi.  
 L, the anus.  
 N, the perinæum.  
 QP, the left hip and thigh.  
 R, the skin and muscular parts of the loins.

Fig. 3. shews the head of the fœtus, by strong labour-pains, squeezed into a longish form, with a tumour on the vertex, from a long compression of the head in the pelvis.

K, the tumour on the vertex.

L, the forceps.

M, the vesica urinaria much distended with a large quantity of urine from the long pressure of the head against the urethra.

N, the under part of the uterus.

OO, the os uteri.

Fig. 4. shews, in the lateral view, the face of the child presenting and forced down into the lower part of the pelvis, the chin being below the pubes, and the vertex in the concavity of the os sacrum: the water being likewise all discharged, the uterus appears closely joined to the body of the child.

Fig. 5. shews, in a lateral view, the head of the child in the same position as in the former figure.

AB, the vertebrae of the loins, os sacrum, and coccyx.

C, the os pubis of the left side.

D, the inferior part of the rectum.

E, the perinæum.

F, the left labium pudendi.

GGG, the uterus.

Fig. 6. gives a lateral internal view of a distorted pelvis, divided longitudinally, with the head of a fœtus of the seventh month passing the fame.

ABC, the os sacrum and coccyx.

D, the os pubis of the left side.

E, the tuberosity of the os ischium of the same side.

Fig. 7. gives a side-view of a distorted pelvis, divided longitudinally, with the head of a full grown fœtus squeezed into the brim, the parietal bones decussating each other, and compressed into a conical form.

ABC, the os sacrum and coccyx.

D, the os pubis of the left side.

E, the tuberosity of the os ischium.

F, the processus acutus.

G, the foramen magnum.

Plate CLXXX. Fig. 1. shews, in a front view of the pelvis, the breech of the fœtus presenting, and dilating the os internum, the membranes being too soon broke.

Fig. 2. is the reverse of fig. 1. the fore-parts of the child being to the fore-part of the uterus.

Fig. 3. represents, in a front-view of the pelvis, the fœtus compressed, by the contraction of the uterus, into a round form, the fore-parts of the former being towards the inferior part of the latter, and one foot and hand fallen down into the vagina. In this figure, the anterior part of the pelvis is removed, by a longitudinal

section through the middle of the foramea magnum.

AA, the superior parts of the ossa ilium.

BB, the uterus.

C, the mouth of the womb stretched and appearing in

OOOO, the vagina.

D, the inferior and posterior part of the os externum.

EEEE, the remaining parts of the ossa pubis and ischium.

FFFF, the membrana adiposa.

Fig. 4. represents, in the same view with fig. 3. the fœtus in the contrary position; the breech and fore-parts being towards the fundus uteri, the left arm in the vagina, and the fore-arm without the os externum, the shoulder being likewise forced into the os uteri.

Fig. 5. represents, in a lateral view of the pelvis, the method of extracting, by means of a curved crotchet, the head of the fœtus, when left in the uterus, after the body is delivered and separated from it; either by its being too large, or the pelvis too narrow.

ABC, the os sacrum and coccyx.

D, the os pubis of the left side.

EE, the uterus.

F, the locking part of the crotchet.

g, h, i, the point of the crotchet on the inside of the cranium.

Fig. 6. represents the forceps and blunt-hook.

A, the straight forceps, in the exact proportion as to the width between the blades, and length from the points to the locking-part; the first being two and the second six inches, which, with three inches and a half, (the length of the handles), make in all eleven inches and a half.

B represents the posterior part of a single blade in order to shew the width and length of the open part of the fame, and the form and dimensions of the whole.

C, the blunt hook, which is used for three purposes: 1. To assist the extraction of the head, after the cranium is opened with the scissars, by introducing the small end along the ear on the outside of the head to above the under-jaw, where the point is to be fixed; the other extremity of the hook being held with one hand, whilst two fingers of the other are to be introduced into the forehead opening, by which holds the head is to be gradually extracted. 2. The small end is useful in abortions, in any of the first four or five months, to hook down the secundines, when lying loose in the uterus, when they cannot be extracted by the fingers or labour-pains, and when the patient is much weakened by floodings. 3. The large hook at the other end is useful to assist the extraction of the body, when the breech presents; but should be used with great caution, to avoid the dislocation or fracture of the thigh.

Fig. 7. A represents the whale-bone fillet, which may be sometimes useful in laborious cases, when the operator is not provided with the forceps, in sudden and unexpected exigencies.

BB, two views of a pessary for the prolapsus uteri. After the uterus is reduced, the large end of the pessary is to be introduced into the vagina, and the os uteri retained in the concave part, where there are three

Explant.  
of  
Plates.

holes to prevent the stagnation of any moisture. The small end without the os externum has two tapes drawn through the two holes, which are tied to four other tapes, that hang down from a belt that surrounds the woman's body, and by this means keep up the pessary. This pessary may be taken out by the patient when she goes to bed, and introduced again the morning; but as this sometimes rubs the os externum, so as to make its use uneasy, the round kind, marked C, are of more general use. They are made of wood, ivory, or cork, (the last covered with cloth and dipped in wax:) the pessary is to be lubricated with pomatum, the edge forced through the passage into the vagina, and a finger introduced in the hole in the middle lays it across within the os externum. They ought to be larger or smaller, according to the wideness or narrowness of the passage, to prevent their being forced out by any extraordinary straining.

DD gives two views of a female catheter, to show

Explant.  
of  
Plates.

its degree of curvature and different parts.

Fig. 8. a, represents a pair of curved crotchets locked together in the same manner as the forceps. The dotted lines along the inside of one of the blades represent a sheath contrived to guard the point till it is introduced high enough: the ligature at the handles marked with two dotted lines is then to be untied, the sheath withdrawn, and the point being uncovered is fixed as in fig. 5.

b, gives a view of the back part of one of the crotchets, which is 12 inches long.

c, a front view of the point, to show its proportional length and breadth.

d, the Cissars for perforating the cranium in very narrow and distorted pelvises. They ought to be made very strong, and at least nine inches in length, with flops or reits in the middle of the blades, by which a large dilatation is more easily made.

## M I G

Migdol  
||  
Migration.

MIGDOL, or MAGDOL, (anc. geog.), a place in the Lower Egypt, on this side Pihahiroth, or between it and the Red-Sea, towards its extremity. The term denotes a tower or fortress. It is probably the *Magdalu* of Herodotus; seeing the Septuagint render it by the same name.

MIGNARD (Nicholas), a very ingenious French painter, born at Troyes in 1628; but, settling at Avignon, is generally distinguished from his brother Peter by the appellation of *Mignard of Avignon*. He was afterwards employed at court and at Paris, where he became rector of the royal academy of painting. There are a great number of his historical pieces and portraits in the palace of the Tuilleries. He died in 1690.

MIGNARD (Peter), the brother of Nicholas, was born at Troyes in 1610; and acquired so much of the taste of the Italian school as to be known by the name of the *Roman*. He was generally allowed to have a superior genius to his brother Nicholas; and had the honour of painting the popes Alexander VII. and Urban VIII. besides many of the nobility at Rome, and divers of the Italian princes: his patron, Lewis, sat ten times to him for his portrait, and respected his talents so much as to ennoble him, make him his principal painter after the death of Le Brun, and appoint him director of the manufactories. He died in 1695; and many of his pieces are to be seen at St Cloud.

MIGNON (Abraham), a celebrated painter, born at Francfort, acquired a great reputation by his skill in representing flowers, fruits, insects, flies, birds, and fishes. His colouring is admirable; and the dew spread on the flowers is so well imitated in his pictures, that one is tempted to take hold of them.

MIGRATION, the passage or removal of a thing out of one place into another.

MIGRATION of Birds.—It has been generally believed that many different kinds of birds annually pass from one country to another, and spend the summer or the winter where it is most agreeable to them; and that even the birds of our own island will seek the most distant southern regions of Africa, when directed by a peculiar instinct to leave their own country. It hath long been an opinion pretty generally received, that

## M I G

swallows reside during the winter-season in the warm Migration.

southern regions; and Mr Adanson particularly relates his having seen them at Senegal when they were obliged to leave this country. But besides the swallow, Mr Pennant enumerates many other birds which migrate from Britain at different times of the year, and are then to be found in other countries; after which they again leave these countries, and return to Britain. The reason of these migrations he supposes to be a defect of food at certain seasons of the year, or the want of a secure asylum from the persecution of man during the time of courtship, incubation, and nutrition.—The following is his list of the migrating species.

1. *Crow*. Of this genus, the hooded crow migrates regularly with the woodcock. It inhabits North Britain the whole year: a few are said annually to breed on Dartmoor, in Devonshire. It breeds also in Sweden and Austria: in some of the Swedish provinces it only shifts its quarters, in others it resides throughout the year. Our author is at a loss for the summer retreat of those which visit us in such numbers in winter, and quit our country in the spring; and for the reason why a bird, whose food is such that it may be found at all seasons in this country, should leave us.

2. *Cuckoo*. Disappears early in autumn; the retreat of this and the following bird is quite unknown to us.

3. *Wryneck*. Is a bird that leaves us in the winter. If its diet be ants alone, as several assert, the cause of its migration is very evident. This bird disappears before winter, and revisits us in the spring a little earlier than the cuckoo.

4. *Hoopoe*. Comes to England but by accident: Mr Pennant once indeed heard of a pair that attempted to make their nest in a meadow at Selborne, Hampshire, but were frightened away by the curiosity of people. It breeds in Germany.

5. *Grouse*. The whole tribe, except the quail, lives here all the year round: that bird either leaves us, or else retires towards the sea-coasts.

6. *Pigeons*. Some few of the ring-doves breed here; but the multitude that appears in the winter, is so disproportioned to what continue here the whole year, as to make it certain that the greatest part quit

the

the country in the spring. It is most probable they go to Sweden to breed, and return from thence in autumn; as Mr Ekmark informs us they entirely quit that country before winter. Multitudes of the common wild pigeons also make the northern retreat, and visit us in winter; not but numbers breed in the high cliffs in all parts of this island. The turtle also probably leaves us in the winter, at least changes its place, removing to the southern counties.

7. *Stare*. Breeds here. Possibly several remove to other countries for that purpose, since the produce of those that continue here seems unequal to the clouds of them that appear in winter. It is not unlikely that many migrate into Sweden, where Mr Berger observes they return in spring.

8. *Thrushes*. The fieldfare and the redwing breed and pass their summers in Norway and other cold countries; their food is berries, which abounding in our kingdoms, tempts them here in the winter. These two and the Ruyton crow are the only land-birds that regularly and constantly migrate into England, and do not breed here. The hawfinch and crossbill come here at such uncertain times as not to deserve the name of birds of passage.

9. *Chatterer*. The chatterer appears annually about Edinburgh in flocks during winter; and feeds on the berries of the mountain-ash. In South Britain it is an accidental visitant.

10. *Grasbeaks*. The grosbeak and crossbill come here but seldom; they breed in Austria. The pine grosbeak probably breeds in the forests of the Highlands of Scotland.

11. *Buntings*. All the genus inhabits England throughout the year; except the greater brambling, which is forced here from the north in very severe seasons.

12. *Finches*. All continue in some parts of these kingdoms, except the siskin, which is an irregular visitant, said to come from Russia. The linnets shift their quarters, breeding in one part of this island, and remove with their young to others. All finches feed on the seeds of plants.

13. *Larks, fly-catchers, wagtails, and warblers*. All of these feed on insects and worms; yet only part of them quit these kingdoms; though the reason of migration is the same to all. The nightingale, black-cap, fly-catcher, willow-wren, wheat-ear, and white-throat, leave us before winter, while the small and delicate golden-crested wren braves our severest frosts. The migrants of this genus continue longest in Great Britain in the southern counties, the winter in those parts being later than in those of the north; Mr Stillingfleet having observed several wheat-ears in the isle of Purbeck on the 18th of November. As these birds are incapable of very distant flights, Spain, or the south of France, is probably their winter-asylum.

14. *Swallows and goat-sucker*. Every species disappears at the approach of winter.

#### WATER-FOWL.

Of the vast variety of water-fowl that frequent Great Britain, it is amazing to reflect how few are known to breed here: the cause that principally urges them to leave this country, seems to be not merely the want of food, but the desire of a secure retreat. Our country is too populous for birds to shy and timid as

the bulk of these are: when great part of our island was a mere waste, a tract of woods and fen; doubtless many species of birds (which at this time migrate) remained in security throughout the year. Egrets, a species of heron, now scarce known in this island, were in former times in prodigious plenty; and the crane, that has totally forsaken this country, bred familiarly in our marshes: their place of incubation, as well as of all other cloven-footed water-fowl (the heron excepted) being on the ground, and exposed to every one: as rural economy increased in this country, these animals were more and more disturbed; at length, by a series of alarms, they were necessitated to seek, during the summer, some lonely safe habitation.

On the contrary, those that build or lay in the almost inaccessible rocks that impend over the British seas, breed there still in vast numbers, having little to fear from the approach of mankind: the only disturbance they meet with in general being from the desperate attempts of some few to get their eggs.

#### CLOVEN-FOOTED WATER-FOWL.

15. *Heron*. The white heron is an uncommon bird, and visits us at uncertain seasons; the common kind and the bittern never leave us.

16. *Curlews*. The curlew breeds sometimes on our mountains; but, considering the vast flights that appear in winter, it is probable that the greater part retire to other countries: the whimbrel breeds on the Grampian hills, in the neighbourhood of Invercauld.

17. *Sniepes*. The woodcock breeds in the moist woods of Sweden, and other cold countries. Some snipes breed here, but the greatest part retire elsewhere; as do every other species of this genus.

18. *Sandpipers*. The lapwing continues here the whole year; the ruff breeds here, but retires in winter; the redshank and sandpiper breed in this country, and reside here. All the others absent themselves during summer.

19. *Plovers and oyster-catcher*. The long-legged plover and fanderling visit us only in winter; the dotterel appears in spring and in autumn; yet, what is very singular, we do not find it breeds in South Britain. The oyster-catcher lives with us the whole year. The Norfolk plover and sea-lark breed in England. The green plover breeds on the mountains of the north of England, and on the Grampian hills.

We must here remark, that every species of the genera of curlews, woodcocks, sandpipers, and plovers, that forsake us in the spring, retire to Sweden, Poland, Prussia, Norway, and Lapland, to breed: as soon as the young can fly, they return to us again, because the frosts which set in early in those countries totally deprive them of the means of subsisting; as the dryness and hardness of the ground, in general, during our summer, prevent them from penetrating the earth with their bills, in search of worms, which are the natural food of these birds. Mr Ekmark speaks thus of the retreat of the whole tribe of cloven-footed water fowl out of his country (Sweden) at the approach of winter; and Mr Klein gives much the same account of those of Poland and Prussia.

20. *Rails and gallinules*. Every species of these two genera continue with us the whole year; the land-rail excepted, which is not seen here in winter. It likewise continues in Ireland only during the summer-months,

Migration.

when they are very numerous, as Mr Smith tells us in the *History of Waterford*, p. 336. Great numbers appear in Anglesea the latter end of May; it is supposed that they pass over from Ireland, the passage between the two islands being but small. As we have instances of these birds lighting on ships in the channel and the Bay of Biscay, we may conjecture their winter-quarters to be in Spain.

## FINNED-FOOTED WATER-BIRDS.

21. *Phalaropes*. Visit us but seldom; their breeding place is Lapland, and other arctic regions.

22. *Grebes*. The great-crowned grebe, the black and white grebe, and little grebe, breed with us, and never migrate; the others visit us accidentally, and breed in Lapland.

## WEB-FOOTED BIRDS.

23. *Avocets*. Breed near Fosdike in Lincolnshire; but quit their quarters in winter. They are then shot in different parts of the kingdom, which they visit, not regularly, but accidentally.

24. *Auks and guillemots*. The great auk or penguin sometimes breeds in St Kilda. The auk, the guillemot, and puffin, inhabit most of the maritime cliffs of Great Britain, in amazing numbers, during summer. The black guillemot breeds in the Bass Isle, and in St Kilda; and sometimes in Llandidno rocks. We are at a loss for the breeding place of the other species; neither can we be very certain of the winter residence of any of them, excepting of the lesser guillemot and black-billed auk, which, during winter, visit in vast flocks the Frith of Forth.

25. *Divers*. These chiefly breed in the lakes of Sweden and Lapland, and some in countries near the pole; but some of the red-throated divers, the northern and the imber, may breed in the north of Scotland and its isles.

26. *Terns*. Every species breeds here; but leaves us in the winter.

27. *Petrels*. The fulmar breeds in the Isle of St Kilda, and continues there the whole year, except September and part of October: the shearwater visits the Isle of Man in April; breeds there; and, leaving it in August or the beginning of September, disperses over all parts of the Atlantic ocean. The stormfinch is seen at all distances from land on the same vast watery tract; nor is ever found near the shore except by some very rare accident, unless in the breeding season. Mr Pennant found it on some little rocky isles, off the north of Skie. It also breeds in St Kilda. He also suspects that it nestles on the Blasket Isles off Kerry, and that it is the goulder of Mr Smith.

28. *Mergansers*. This whole genus is mentioned among the birds that fill the Lapland lakes during summer. Mr Pennant has seen the young of the red-breasted in the north of Scotland: a few of these, and perhaps of the goosanders, may breed there.

29. *Ducks*. Of the numerous species that form this genus, we know of few that breed here. The swan and goose, the shield-duck, the eider-duck, a few shovellers, garganics, and teal, and a very small portion of the wild ducks.

The rest contribute to form that amazing multitude of water-fowl that annually repair from most parts of Europe to the woods and lakes of Lapland and other arctic regions, there to perform the functions of

incubation and nutrition in full fertility. They and Migration. their young quit their retreat in September, and disperse themselves over Europe. With us they make their appearance the beginning of October; circulate first round our shores; and, when compelled by severe frost, betake themselves to our lakes and rivers. Of the web-footed fowl there are some of hardier constitutions than others: these endure the ordinary winters of the more northern countries; but when the cold reigns there with more than common rigour, repair for shelter to these kingdoms: this regulates the appearance of some of the diver kind, as also of the wild swans, the swallow-tailed shield-duck, and the different sorts of goosanders which then visit our coasts. Barentz found the barnacles with their nests in great numbers in Nova Zembla. *Collect. Voy. Dutch East-India Company*, 8vo. 1703, p. 19. Cluſius, in his *Exot.* 368. also observes, that the Dutch discovered them on the rocks of that country and in Waygate Straits. They, as well as the other species of wild-geese, go very far north to breed, as appears from the histories of Greenland and Spitzbergen, by Egede and Crantz. These birds seem to make Iceland a resting place, as Horrebow observes: few continue there to breed, but only visit that island in the spring, and after a short stay retire still further north.

30. *Corvorants*. The corvorant and shag breed on most of our high rocks: the gannet in some of the Scotch isles, and on the coast of Kerry: the two first continue on our shores the whole year. The gannet disperses itself all round the seas of Great Britain, in pursuit of the herring and pilchard, and even as far as the Tagus to prey on the sardina.

But of the numerous species of fowl here enumerated, it may be observed how very few entrust themselves to us in the breeding season, and what a distant flight they make to perform the first great dictate of nature.

There seems to be scarcely any but what we have traced to Lapland, a country of lakes, rivers, swamps, and alps, covered with thick and gloomy forests, that afford shelter during summer to these fowls, which in winter disperse over the greatest part of Europe. In those arctic regions, by reason of the thickness of the woods, the ground remains moist and penetrable to the woodcocks, and other slender-billed fowl: and for the web-footed birds, the waters afford larvæ innumerable of the tormenting knat. The days there are long; and the beautiful meteorous nights indulge them with every opportunity of collecting so minute a food: whilst mankind is very sparingly scattered over that vast northern waste.

Why then should Linnæus, the great explorer of these rude deserts, be amazed at the myriads of water-fowl that migrated with him out of Lapland? which exceeded in multitude the army of Xerxes; covering, for eight whole days and nights, the surface of the river Calix. His partial observation as a botanist, would confine their food to the vegetable kingdom, almost denied to the Lapland waters; inattentive to a more plenteous table of insect-food, which the all-bountiful Creator had spread for them in the wilderness. It may be remarked, that the lakes of mountainous rocky countries in general are destitute of plants: few and none are seen on those of Switzerland; and Linnæus makes



Migration. makes the same observation in respect to those of Lapland; having, during his whole tour, discovered only a single specimen of a *lemna trifidula*, or "ivy-leaved duck's meat," *Flora Lap.* n° 470.; a few of the *scirpus lacustris*, or "bullrush," n° 18.; the *alopecurus gemiculatus*, or "flood foxtail grass," n° 38.; and the *ramunculus aquatilis*, n° 234.; which are all he enumerates in his *Prolegomena* to that excellent performance.

Under the article *Hirundo*, we have given the principal arguments for and against the migration of swallows. Here we shall give a short abstract of the arguments used by the Hon. Daines Barrington against the migration of birds in general, from a paper published by him in the 62d volume of the Philosophical Transactions. This gentleman denies, as any well-attested instances can be produced of this supposed migration, which, if there were any such periodical flight, could not possibly have escaped the frequent observation of seamen. It has indeed been asserted that birds of passage become invisible in their flight, because they rise too high into the air to be perceived, and because they choose the night for their passage. The author, however, expresses his doubts "whether any bird was ever seen to rise to a greater height than perhaps twice that of St Paul's cross;" and he further endeavours to shew, that the extent of some of these supposed migrations (from the northern parts of Europe, for instance, to the line) is too great to be accounted for, by having recourse to the argument founded on a nocturnal passage.

The author next recites, in a chronological order, all the instances that he has been able to collect, of birds having been actually seen by mariners when they were crossing a large extent of sea; and he endeavours to shew that no stress can be laid on the few casual observations of this kind that have been produced in support of the doctrine of a regular and periodical migration.

Mr Barrington afterwards proceeds to invalidate M. Adanson's celebrated observation with respect to the migration of the swallow in particular, and which has been considered by many as perfectly decisive of the present question. He endeavours to shew that the four swallows which that naturalist caught, on their settling upon his ship, on the 6th of October at about the distance of 50 leagues from the coast of Senegal, and which he supposes to have been then proceeding from Europe to pass the winter in Africa, could not be true European swallows; or, if they were, could not have been on their return from Europe to Africa. His objections are founded principally on some proofs which he produces of M. Adanson's want of accuracy on this subject, which has led him, in the present instance, to mistake two African species of the swallow-tribe, described and engraved by Brisson, for European swallows, to which they bear a general resemblance: or granting even that they were European swallows, he contends, that they were sitting from the Cape de Verd Islands to the coast of Africa; "to which short flight, however, they were unequal, and accordingly fell into the sailor's hands."

After many observations and reflections on the subject, the author endeavours to support the opinion that swallows, and perhaps some other supposed birds of passage, remain with us during the winter in a torpid

state; observing that, notwithstanding the great care which they take to conceal themselves, it is certain that they have been frequently found, during the period of their supposed absence, lying hid in caverns, or hollow trees, and even under water. Besides other instances, well known to those who have attended to this subject, the author gives us the testimony of Mr Stephens A. S. S. who assured him that he had himself picked up a cluster of three or four swallows (or martins) out of a pond of his father's at Shrivernham in Berkshire, in the month of February; that they were caked together in the mud; and that, on carrying them into the kitchen, they soon flew about the room, in the presence of his father, mother, and others. The same fact was afterwards confirmed to the author by Dr Pye, who was then Mr Stephens's school-fellow at Shrivernham, and by another gentleman who now lives in that village.

It may naturally be asked, why swallows, in particular, are not frequently thus found in their torpid state. In answer to this question the author observes, that the same instinct which prompts the bird thus to conceal itself, instructs it to choose such a place of security, that common accidents will not discover it;—that ponds are seldom cleaned in the winter, as it is such cold work for the labourers;—that facts of this sort are little attended to; and that the common labourers who have the best chance of finding torpid birds, make no mention of the discovery to others, as they consider it as a thing of course, and consequently not interesting to any one. He adds, that swallows may be constantly taken in the month of October, and even so late as November, during the dark night, while they sit on the willows in the Thames; and that one may almost instantaneously fill a large sack with them, because at this time they will not stir from the twigs when you lay your hands upon them. This, says the author, looks very much like their beginning to be torpid, before they hide themselves under the water.

To this argument, however, the monthly reviewers oppose the following, which appears to them decisive in favour of migration. The swallow, it is supposed, like other birds, moults once a-year at least: but during the whole time this bird is seen with us, it appears in full feather. The process of moulting, therefore, must be performed somewhere: but as it is absurd to suppose that this great change can be effected in these birds while they are lying asleep, or torpid in caverns and hollow trees, or immersed in clusters in the mud at the bottom of ponds or rivers, they must moult in some distant country, to which they retire when they disappear in these parts.

MIGRATION of *Fishes*. See CLUPEA.

*St MIGUEL*, one of the *Azore* islands, situated in W. Long. 22. 45, N. Lat. 38. 10. This island appears to be entirely volcanic. The best account we have of it hath been published in the 68th volume of the Philosophical Transactions by Mr Francis Masson. According to him, the productions differ greatly from those of *Madeira*, inasmuch that none of the trees of the latter are found here, except the *Luya*: it has a nearer affinity to Europe than Africa. The mountains are covered with the *Erica vulgaris*, and an elegant

Migration,  
Miguel.

Migration,  
Miguel.

elegant ever-green shrub very like a phillyrea, which gives them a most beautiful appearance.

It is one of the principal and most fertile of the Azorian islands, lying nearly east and west; its length is about 18 or 20 leagues; its breadth unequal, not exceeding five leagues, and in some places not more than two. It contains about 80000 inhabitants.

Its capital, the city of Ponta del Guda, which contains about 12000 inhabitants, is situated on the south side of the island, on a fine fertile, plain country, pretty regularly built; the streets straight, and of a good breadth. It is supplied with good water, which is brought about the distance of three leagues from the neighbouring mountains. The churches and other religious edifices are elegant and well built for such an island. There is a large convent of Franciscan friars and one of the order of St Augustin, four convents for professed nuns, and three Recoilimentos for young women and widows who are not professed. The vessels anchor in an open road; but it is not dangerous, as no wind can prevent their going to sea in case of stormy weather.

The country round the city is plain for several miles, well cultivated, and laid out with good taste into spacious fields, which are sown with wheat, barley, Indian corn, pulse, &c. and commonly produce annually two crops; for as soon as one is taken off, another is immediately sown in its place. The soil is remarkably gentle and easy to work, being for the most part composed of pulverized pumice-stone. There are in the plains a number of pleasant country-seats, with orchards of orange trees, which are esteemed the best in Europe.

The second town is Ribeira Grande, situated on the north side of the island, containing about as many inhabitants as the city; a large convent of Franciscan friars, and one of nuns. It gives title to a count, called the *Conde Ribeira Grande*, who first instituted linen and woollen manufactories in the island.

The third town is Villa Franca, on the south side of the island, about six leagues east of Ponta del Guda. It has a convent of Franciscan friars, and one of nuns, which contains about 300. Here, about half a mile from the shore, lies a small island (Ilhao), which is hollow in the middle, and contains a fine basin with only one entrance into it, fit to hold fifty sail of vessels secure from all weather; at present it wants cleaning out, as the winter's rain washes down great quantities of earth into it, which has greatly diminished its depth. But vessels frequently anchor between this island and the main.

Beside these towns are several smaller, viz. Alagoa, Agoa de Pao, Brelanha, Fanaes de Ajuda, and a number of hamlets, called *lugars*, or *places*.

About four leagues north-east from Villa Franca, lies a place called the *Furnas*, being a round deep valley in the middle of the east part of the island, surrounded with high mountains, which, though steep, may be easily ascended on horseback by two roads. The valley is about five or six leagues in circuit. The face of the mountains, which are very steep, is entirely covered with beautiful ever-greens, viz. myrtles, laurels, a large species of bilberry called *uva de ferro*, &c. and numberless rivulets of the purest water run down their sides. The valley below is well cultivated,

producing wheat, Indian corn, flax, &c. The fields are planted round with a beautiful sort of poplars, which grow into pyramidal forms, and by their careles, irregular disposition, together with the multitude of rivulets, which run in all directions through the valley, a number of boiling fountains throwing up clouds of steam, a fine lake in the south-west part about two leagues round, compose a prospect the finest that can be imagined. In the bottom of the valley the roads are smooth and easy, there being no rocks but a fine pulverized pumice-stone that the earth is composed of.

There are a number of hot fountains in different parts of the valley, and also on the sides of the mountains: but the most remarkable is that called the *chaldreira*, situated on the eastern part of the valley, on a small eminence by the side of a river, on which is a basin about 30 feet diameter, where the water continually boils with prodigious fury. A few yards distant from it is a cavern in the side of the bank, in which the water boils in a dreadful manner, throwing out a thick, muddy, unctuous water several yards from its mouth with a hideous noise. In the middle of the river are several places where the water boils up so hot, that a person cannot dip his finger into it without being scalded; also along its banks are several apertures, out of which the steam rises to a considerable height, so hot that there is no approaching it with one's hand: in other places, a person would think that 100 smiths bellows were blowing all together, and sulphurous steams issuing out in thousands of places; so that native sulphur is found in every chink, and the ground covered with it like hoar-frost; even the bushes that happen to lie near these places are covered with pure brimstone, condensing from the steam that issues out of the ground, which in many places is covered over with a substance like burnt alum. In these small caverns, where the steam issues out, the people often boil their yams.

Near these boiling fountains are several mineral springs; two in particular, whose waters have a very strong mineral quality, of an acid taste, and bitter to the tongue.

About half a mile to the westward, and close by the river side, are several hot springs, which are used by sick people with great success. Also, on the side of a hill west of St Ann's church, are many others, with three bathing-houses, which are most commonly used. These waters are very warm, altho' not boiling hot; but at the same place issue several streams of cold mineral water, by which they are tempered, according to every one's liking.

About a mile south of this place, and over a low ridge of hills, lies a fine lake about two leagues in circumference, and very deep, the water thick, and of a greenish colour. At the north end is a plain piece of ground, where the sulphurous steams issue out in many places, attended with a hissing blowing noise. Our author could observe strong springs in the lake, but could not determine whether they were hot or cold: this lake seems to have no visible evacuation. The other springs immediately form a considerable river, called *Ribeira Quente*, which runs a course about two or three leagues, thro' a deep rent in the mountains, on each side of which are several places where the smoke

Miguel.

issues out. It discharges itself into the sea on the fourth side, near which are some places where the water boils up at some distance in the sea.

This wonderful place had been taken little notice of until very lately: so little curiosity had the gentlemen of the island, that scarcely any of them had seen it, until of late some persons, afflicted with very virulent disorders, were persuaded to try its waters, and found immediate relief from them. Since that time it has become more and more frequented; several persons who had lost the use of their limbs by the dead palsy have been cured; and also others who were troubled with eruptions on their bodies.

A clergyman, who was greatly afflicted with the gout, tried the said waters, and was in a short time perfectly cured, and has had no return of it since. When Mr Maffon was there, several old gentlemen, who were quite worn out with the said disorder, were using the waters, and had received incredible benefit from them; in particular, an old gentleman, about 60 years of age, who had been tormented with that disorder more than 20 years, and often confined to his bed for six months together: he had used these waters about three weeks, had quite recovered the use of his limbs, and walked about in the greatest spirits imaginable. A feiar also who had been troubled with the said disorder about 12 years, and reduced to a cripple, by using them a short time was quite well, and went a-hunting every day,

There are several other hot springs in the island, particularly at Ribeira Grande; but they do not possess the same virtues, at least not in so great a degree.

The east and west part of the island rises into high mountains; but the middle is low, interspersed with round conic hills, all of which have very recent marks of fire; all the parts below the surface consisting of melted lava lying very hollow.

Most of the mountains to the westward have their tops hollowed out like a punch-bowl, and contain water. Near the west end is an immense deep valley, like the Furnas called the *Sets Cidades*. This valley is surrounded with very abrupt mountains, about seven or eight leagues round; in the bottom is a deep lake of water, about three leagues in circuit, furnished with great number of water-fowls. This water has no mineral quality; neither are there any hot springs in the valley. All these mountains are composed of a white crumbly pumice-stone, which is so loose, that, if a person thrust a stick into the banks, whole wagon-loads of it will tumble down. The inhabitants of the island relate a story, that he who first discovered it observed an extraordinary high peak near the west end; but the second time he visited it, no such peak was to be seen, which he supposed must have certainly sunk; but, however improbable this story may be, at some period or another it must have certainly been the case.

MILAN, or the duchy of the Milanese, a country of Italy, bounded on the west by Savoy, Piedmont, and Montserrat; by Switzerland on the north; by the territories of Venice, the duchies of Mantua, Parma, and Placentia, on the east; and by the territories of Genoa on the south. Anciently this duchy, containing the north part of the Old Liguria, was called *In-*

*subria*, from its inhabitants the *Insabres*; who were conquered by the Romans, as these were by the Goths; who in their turn were subdued by the Lombards. Didier, the last king of the Lombards, was taken prisoner by Charlemagne, who put an end to the Longobardic empire, and appointed governors of Milan. These governors, being at a distance from their masters, soon began to assume an independency, which brought a dreadful calamity on the country; for, in 1152, the capital itself was levelled with the ground by the emperor Frederic Barbarossa, who committed great devastations otherwise throughout the duchy. Under this emperor lived one Galvian, a nobleman who was descended from Otho a Milanese. Galvian, along with William prince of Montserrat, served in the crusade, when Godfrey of Boulogne took Jerusalem: he killed in single combat the Saracen general, whom he stripped of his helmet, which was adorned with the image of a serpent swallowing a youth; and this ever afterwards was the badge of that family. His grandson Galvian, having opposed the emperor, was taken prisoner, and carried in irons into Germany, from whence he made his escape, and returning to Milan, died in the service of his country. From him descended another Otho, at the time that Otho IV. was emperor of Germany, and who soon distinguished himself by the accomplishments both of his mind and body. When he grew up, he was received into the family of cardinal Octavian Ubaldini at Rome.

This prelate, who was himself aspiring at the popedom, was in a short time greatly taken with the address and accomplishments of young Otho, and predicted his future greatness. In the mean time, one Torresis, or Torriano, a Milanese nobleman of unbounded ambition, was attempting to make himself master of Milan. The popular faction had some time before been caballing against the nobility; and at last, Torriano, putting himself at their head, expelled the bishop, and put to death or banished all the nobility: by which means the popular government was fully established; and Torriano, under this pretence, ruled every thing as he pleased. He was, however, soon opposed by one Francisco Sepri, who formed a great party, pretending to deliver the city from Torriano's haughtiness and cruelty. But while the two parties were collecting their forces against each other, cardinal Ubaldini was projecting the destruction of both, by means of his favourite Otho. This prelate had for some time borne an implacable hatred to Torriano, because he had been by him prevented from carrying out of the treasury of St Ambrose's church at Milan, a carbuncle or jewel of great value, which he pretended to reserve for adorning the papal tiara; for which reason he now determined to oppose his ambition.

Ubaldini began with naming Otho archbishop of Milan; which, as the pope's legate, he had a right to do. This nomination was confirmed by Pope Urban IV.; and the party of the nobility having now got a head from the pope himself, began to gather strength. Otho in the mean time employed himself in collecting troops; and had no sooner procured a shew of an army, than he advanced towards Lago Maggiore, and took possession of Arona, a strong post near that lake: but Torriano, marching immediately against

Milan.

against him with all his troops, obliged him to abandon the place, and leave his party to make the best terms they could with the conqueror. This was followed by the destruction of the castles of Arona, Angliari, and Brebia: soon after which Torriano died; and was succeeded by his brother Philip, who had sufficient interest to get himself elected podestà, or prætor of Milan, for ten years. During his lifetime, however, the party of the nobility increased considerably under Otho, notwithstanding the check they had received. Philip died in 1265, having lost ground considerably in the affections of the people, though he obtained a great reputation for his courage and conduct. His successor Napi rendered himself terrible to the nobility, whom he proscribed, and put to death as often as he could get them into his power. He proceeded such lengths, and acted with such fury against that unfortunate party, that pope Clement IV. who had succeeded Urban, at last interdicted Milan, and excommunicated Napi and all his party. By this Napi began to lose his popularity, and the public disaffection towards him was much heightened by the natural cruelty of his temper. But in the mean time, the party of the nobility was in the utmost distress. Otho himself and his friends, having spent all their substance, wandered about from place to place; the pope not being in a capacity of giving them any assistance. Otho, however, was not discouraged by his bad success, but found means still to keep up the spirits of his party, who now chose for their general Squarcini Burri, a man of great eminence and courage, whose daughter was married to Matthew Visconti, afterwards called *Matthew the Great*. At the same time they renewed their confederacy with the marquis of Montferrat, who was son-in-law to the king of Spain. The marquis agreed to this confederacy chiefly with a view to become master of the Milanese.

The nobility now again began to make head; and having collected an army, which was joined by 600 Spanish cavalry and a body of foot, gained some advantages. But in the mean time Napi, having gathered together a superior army, suddenly attacked Otho and Burri, and defeated them. After this disaster Otho applied to the pope; from whom, however, he did not obtain the assistance he desired; and in the mean time Napi invited the emperor Rodolph into Italy, with the promise of being crowned at Milan. This invitation was accepted of with great readiness by Rodolph; who constituted Napi his governor and vicar-general in Lombardy, sending to him at the same time a fine body of German horse, the command of which was given to Cassoni, Napi's nephew. On this Otho again applied to the pope, (Gregory X.): but he was so far from granting him any assistance, that he is said to have entered into a scheme of assassinating him privately; but Otho escaped the danger, and in 1276 began to recover his affairs. The reason of pope Gregory's enmity to him was, that he and his party were thought to be Gibelines, and were opposed by great numbers of the nobility themselves; but after that pope's death, the Milanese exiles being united under one head, soon became formidable. They now chose for their general Godfrey count of Langusio, a noble Pavian, and an inveterate enemy of the Torriano family. This nobleman being

Milan.

rich and powerful, enlisted many German and other mercenaries, at whose head he marched towards the Lago Maggiore. All the towns in that country opened their gates to him through the interest of the Visconti family, who resided in these parts. But this success soon met with a severe check in an unfortunate engagement, wherein Godfrey was defeated and taken prisoner; after which he and 34 nobles had their heads struck off, and sent from the field of battle piled up in a common waggon.

This defeat greatly affected Otho; but having in a short time recovered himself, he again attacked his enemies, and defeated them; but, suffering his troops to grow remiss after their victory, the fugitives rallied, and entirely defeated him. The next year, however, Otho had better success, and totally defeated and took prisoner Napi himself. After this victory Cassoni was obliged to abandon Milan to his competitor, who kept possession of it till his death, which happened in 1295, in the 87th year of his age.

Otho was succeeded by Matthew Visconti above-mentioned; and Milan continued in subjection to that family without any very memorable occurrence, till the year 1378, when, by the death of Galeazzo II. his brother Barnabo became sovereign of Milan. He was of a brave and active disposition; but excessively profuse in his expences, as his brother Galeazzo had also been; and, to procure money to supply his extravagancies, was obliged to oppress his subjects. Galeazzo had engaged in an enterprise against Bologna, and the siege of it was continued by Barnabo. It lasted for nine years, and during this time is said to have cost 300 millions of gold, a prodigious sum in those days, near 40 millions sterling; the lowest gold coin being in value somewhat more than half-a-crown English. Both the brothers were excessively fond of building. Barnabo erected a bridge over the Adda, consisting of three stories, the lowest for chariots and heavy carriages, the middle for horses; and the uppermost for foot-passengers. He built also another bridge which was carried over houses without touching them. To accomplish these, and many other expensive schemes, he became one of the greatest tyrants imaginable, and every day produced fresh instances of his rapacity and cruelty. He instituted a chamber of inquiry, for punishing all those who had for five years before been guilty of killing boars, or even of eating them at the table of another. They who could not redeem themselves by money were hanged, and above 100 wretches perished in that manner. Those who had any thing to lose were stripped of all their substance, and obliged to labour at the fortifications and other public works. He obliged his subjects to maintain a great many hunting-dogs, and each district was taxed a certain number. The overseers of his dogs were at the same time the instruments of his rapacity. When the dogs were poor and slender, the owners were always fined; but when the dogs were fat, the owners were also fined, for suffering them to live without exercise.

The extravagant behaviour of Barnabo soon rendered public affairs ready for a revolution, which was at last accomplished by his nephew John Galeazzo. He affected a solitary life, void of ambition, and even inclining to devotion; but at the same time took care to have his uncle's court filled with spies, who gave  
him

him information of all that passed. He reduced his table and manner of living, pretending that he took these steps as preparatives to a retirement from the world, which was soon to take place, after he had paid a religious vow. In short, he acted his part so well, that even Barnabo, though abundantly cautious, had no suspicion of his having any designs against him; and so entirely did he conceal his ambition, that he several times made application to his uncle for his interest to procure him a quiet retreat as soon as his religious vows were performed. One of these was to pay a visit to the church of the blessed Virgin upon mount Varezio. This was to be done with so much secrecy that all kinds of eye-witnesses were to be excluded; and it was with difficulty that Barnabo himself and two of his sons were allowed to accompany our devotee. But, in the mean time, the hypocritical Galeazzo had soldiers advancing from all quarters, so that Barnabo and his sons were immediately seized, and the houses of those who had sided with them given up to be plundered. The booty in plate, money, and all kinds of rich furniture, was immense. The ministers of the late government were dragged from their hiding-places, and put to death; and at last the citadel itself fell into the hands of Galeazzo, who found in it an immense sum of money. Barnabo was carried prisoner to Tritico, a castle of his own building, where he had the happiness to find one person still faithful to him. This was his mistress, named *Donnia Porra*; who, when he was abandoned by all the world, shut herself up a voluntary prisoner in his chamber, and remained with him as long as he lived, which was only seven months after his degradation.

John Galeazzo was the first who took upon him the title of the *duke of Milan*, and was a prince of great policy and no less ambition. He made war with the Florentines, became master of Pisa and Bologna, and entirely defeated the emperor in 1401, so that he entertained hopes of becoming master of all Lombardy, and cutting off all possibility of invading it either from France or Germany; but his designs were frustrated by death, which happened in 1402, in the 55th year of his age. After his decease the Milanese government fell into the most violent distractions, so that it could not be supported, even in time of peace, without an army of 20,000 foot and as many horse. In the year 1421, however, Philip duke of Milan became master of Genoa; but though he gained great advantages in all parts of Italy, the different states still found means to counterbalance his successes, and prevent him from enslaving them: so that Milan never became the capital of any extensive empire; and in 1437 Genoa revolted, and was never afterwards reduced.

Philip died in 1448, and by his death the male line of the Visconti family was at an end. The next lawful heir was Valentina his sister, who had married the duke of Orleans son to Charles V. of France. By the contract of that marriage, the lawful progeny of it was to succeed to the duchy of Milan in failure of the heirs-male of the Visconti family; but this succession was disputed by Sforza, who had married Philip's natural daughter. It is certain, however, that the rightful succession was vested in the house of Orleans and the kings of France;

and therefore though the Sforza family got possession of the duchy for the present, Lewis XII. afterwards put in his claim, as being grandson to John Galeazzo. For some time he was successful; but the French behaved in such an insolent manner, that they were driven out of the Milanese by the Swifs and Maximilian Sforza. The Swifs and Milanese were in their turn expelled by Francis I. who obliged the Sforza family to relinquish the government for a pension of 30,000 ducats a-year. Francis Sforza, the son of Maximilian, however, being assisted by the emperor and the pope, regained the possession of the Milanese about the year 1521; and, eight years after, the French king, by the treaty of Cambray, gave up his claim on the duchy.

But, in fact, the emperors of Germany seem to have had the fairest title to the Milanese in right of their being for a long time sovereigns of Italy. On the death of Francis Sforza, therefore, in the year 1536, the emperor Charles V. declared the Milanese to be an imperial fief, and granted the investiture of it to his son Philip II. king of Spain. In his family it continued till the year 1706, when the French and Spaniards were driven out by the imperialists, and the emperor again took possession of it as a fief. It was confirmed to his house by the treaty of Baden in 1714, by the quadruple alliance in 1718, and by the treaty of Aix la Chapelle in 1748.

The duchy of Milan is one of the finest provinces in Italy. It is bounded on the south by the Appennine mountains, and the territory of Genoa; on the north by Switzerland; on the east by the Venetian territories, and the duchies of Mantua, Parma, and Placentia; and on the west by Savoy, Piedmont, and Montserrat; extending from north to south about 100 miles, and from east to west about 108. It is well watered by the Tessino, the Sesia, the Adda, the Po, the Oglio, the Lombrò, Serio, &c. and also by several canals and lakes. Of the latter the Lago Maggiore is between 30 and 40 miles in length, and in some places six or seven miles broad. In it lie the *Boromean islands*, as they are called, viz. Isola Bella and Isola Madre, the beauty of which almost exceeds imagination: art and nature seem to have vied with one another in embellishing them. In each of them is a palace with delicious gardens, belonging to the Boromean family. The water of the lake is clear and of a greenish colour, and abounds with fish. The hills with which it is surrounded present a most charming landscape, being planted with vines and chestnut-trees, interspersed with summer-houses. There is a canal running from it towards Switzerland, with which the city of Milan has a communication. It was anciently called *Lacus Verbanus*. The Lago de Como, which was called by the Latin poets *Lacus Larius*, but had its modern name from the city, near which it lies, extends itself about 30 miles northward from Como, but its greatest breadth is not above five miles. From the Lago Maggiore issues the Tessino; and from that of Como the Adda. Of the other lakes, that of Lugano and Guarda are the chief: that of Guarda was anciently called *Benacus*.

The trade and manufactures of this duchy consist principally in silks, stuffs, stockings, gloves, and handkerchiefs, linen and woollen cloth, hardware, curious

Milan.

works of crystal, agate, hyacinths, and other gems; but their exports are usually far short of their imports.

As to the revenue of the duchy, it must without doubt be very considerable. It is said to have amounted to 2,000,000 of dollars while the duchy was in the hands of the Spaniards.

In the year 1767, the Austrian government of Milan published a law, by which all the rights which the pope or the bishops had till then exercised over ecclesiastics, either with regard to their effects or persons, is transferred to a council established for that purpose at Milan. By the same edict, all ecclesiastics were obliged to sell the estates which they had become possessed of since the year 1722; and no subject, whether ecclesiastic or secular, was to go to Rome to solicit any favour, except letters of indulgence, without the consent of the said council.

MILAN, the capital of the duchy of that name, in Latin *Mediolanum*, is a very large city, and has a wall and rampart round it, with a citadel; yet is thought to be incapable of making any great resistance. The gardens within the city take up a great deal of ground. In the citadel is a foundery for cannon, and an arsenal furnished with arms for 12,000 men. The governor of it is quite independent of the governor-general of the Milanese, who resides in the city, in a large, but old and ill-contrived palace. The yearly income of the governor of Milan is said to be 200,000 guilders. The council belonging to the city is composed of a president and 60 doctors of law, who are all nobles, and independent of the governor-general. Milan hath experienced a great variety of fortune, having been subject sometimes to the French, sometimes to the Spaniards, and sometimes to the Germans. A great number of persons of rank and fortune live in it, especially during the winter. The ladies in France are not allowed more liberty than those of this city: even the austerities of the monastic life are so far mitigated here, that gentlemen have not only the liberty of talking with the nuns, and of rallying and laughing at the grate, but also of joining with them in concerts of music, and of spending whole afternoons in their company. The place where the *beau monde* take the air, either in their coaches or on foot, is the rampart betwixt the Porta Orientale, and the Porta Tosa, where it is straight and broad, and extremely pleasant, being planted with white mulberry-trees, and commanding a prospect on one side of the open country, and on the other of the gardens and vineyards between the ramparts and the city. Milan, which is said to have been built by the Gauls about 200 years after the foundation of Rome, contains a great number of stately edifices, as churches, convents, palaces, and hospitals. The cathedral is a vast pile, all of marble; and though something has been doing for near 400 years towards the outward or inward ornament thereof, it is not yet finished. Of the great number of statues about it, that of St Bartholomew, just dead alive, with his skin hanging over his shoulders, and of Adam and Eve, over the main portal, are the finest. The pillars supporting the roof of the church are all of marble, and the windows finely painted. This church contains a treasure of great value, particularly a shrine of rock-crystal, in which the body of St Charles Borromeo is deposited. The other churches most worthy

a stranger's notice are those of St Alexander, St Jerom, St Giovanni di Casarotti della Passione, that of the Jesuits, and of St Ambrose, in which lie the bodies of the saint, and of the kings Pepin and Bernard. In the Ambrosian college, founded by Frederic Borromeo, 16 professors teach gratis. In the same college is also an academy of painting, with a museum, and a library, containing a vast number of printed books and manuscripts; among the last of which is a translation of Josephus's History of the Jews, done by Rufinus about 1200 years ago, and written on the bark of a tree; St Ambrose's works on vellum, finely illuminated; the orations of Gregory Nazianzen, and the works of Virgil, in folio, with Petrarch's notes. In the museum are Leonardi da Vinci's mathematical and mechanical drawings, in 12 large volumes. The feminary for sciences, the college of the nobles, the Helvetic college, and the mathematical academy, are noble foundations, and stately buildings. Of the hospitals, the most remarkable are the Lazaretto, and that called the *great hospital*; the latter of which receives sick persons, foundlings, and lunatics, and has six smaller hospitals depending on it, with a revenue of 100,000 rixdollars. The number of the inhabitants of this city is said to be about 250,000. It has been 40 times besieged, taken 20 times, and four times almost entirely demolished; yet it hath always recovered itself. It is said that gunpowder is sold here only by one person, and in one place. The court of inquisition is held in the Dominican convent, near the church of Madonna della Gracia. The houses of entertainment, and the ordinaries here, are represented as very indifferent. Mr Keyser says, it is not unusual for young travellers, when they go to any of the taverns in Milan, to be asked, "whether they choose a *letto fornito*, or female bed-fellow," who continues masked till she enters the bed-chamber. Deformed dwarfs, and people with wens, some of them of a prodigious size, are very common in the streets of Milan. The wens are said to be hereditary. The common method of burying here is, to throw the corpses into vaults, without coffins, to the amount of two or three hundred, which cannot fail to fill the air in these places with noxious effluvia. Mr Keyser tells us, that when he was at Milan, goods of any kind might have been brought into the city without search or inquiry, provided a small gratuity was given to the officer. Milan is far short of Turin both in beauty and conveniency, many of the streets being crooked and narrow, and paper-windows much more frequent than in that city; even in grand palaces, the windows are often composed promiscuously of glass and paper. It is not uncommon here for beggars, when they ask alms, to hold out to you a dish, in which is a human skull. Two large canals extend from hence, the one to the Tessino, and the other to the Adda; the Tessino having a communication with the Lago Maggiore, and, by a canal, with the Sesia; and the Adda issuing from the Lago di Como, and having a communication by canals with the Lambrò and Serio. In a void space in one of the streets of Milan, where stood the house of a barber who had conspired with the commissary of health to poison his fellow-citizens, is erected a pillar called *Colonna Infame*, with an inscription to perpetuate the memory.

Milan.

of the execrable design. The environs of this city are very pleasant, being adorned with beautiful seats, gardens, orchards, &c. About two Italian miles from it, at the seat of the Simonetti family, is a building, that would have been a master-piece of its kind had the architect designed it for an artificial echo. It will return or repeat the report of a pistol above 60 times; and any single musical instrument, well touched, will have the same effect as a great number of instruments, and produce a most surprising and delightful concert. E. Long, 15. 35. N. Lat. 38. 32.

MILBORN-PORT, a town of Somersetshire in England, seated on a branch of the river Parret, and sends two members to parliament. W. Long, 2. 28. N. Lat. 51. 5.

MILDEW is said to be a kind of thick, clammy, sweet juice, exhaled from, or falling down upon, the leaves and blossoms of plants. By its thickness and clamminess it prevents perspiration, and hinders the growth of the plant. It sometimes rests on the leaves of trees, in form of a fatty juice, and sometimes on the ears of corn. It is naturally very tough and viscous, and becomes still more so by the sun's heat exhaling its more fluid parts; by which means the young ears of corn are so daubed over, that they can never arrive at their full growth. Bearded wheat is less subject to the mildew than the common sort; and it is observed, that newly-dunged lands are more liable to mildew than others. The best remedy is a smart shower of rain, and immediately afterwards a brisk wind. If the mildew is seen before the sun has much power, it has been recommended to send two men into the field with a long cord, each holding one end, and drawing this along the field through the ears, the dew will be dislodged from them, before the heat of the sun is able to dry it to that viscous state in which it does the mischief. Some also say, that lands which have for many years been subject to mildews, have been cured of it by sowing foot along with the corn, or immediately after it.

Mr J. S. Segar, the author of a treatise upon this subject, observes, that the mildew is of such a sharp corrosive nature, that it raises blisters on the feet of the shepherds who go barefoot, and even consumes the hoofs of the cattle. He suspects that it possesses some arsenical qualities, though he does not pretend to affirm this positively. Its pernicious influence, according to him, is rendered still more powerful by a variety of circumstances; such as sending the cattle into the fields too early in the spring; their drinking water mixed with ice, or but lately thawed; their being kept in stables that are too close and filthy, and which are not sufficiently aired. The same author considers the mildew as a principal cause of epidemical distempers among the cattle. The mildew producing these diseases, he says, is that which dries and burns the grass and leaves. It falls usually in the morning, particularly after a thunder-storm. Its poisonous quality (which does not continue above 24 hours) never operates but when it has been swallowed immediately after its falling. The disorder attacks the stomach, is accompanied with pimples on the tongue, loss of appetite, a debilitation of the aliments in the stomach, a cough, and difficulty of respiration. As a preservative, the author prescribes purging in spring

and in winter. The medicine he advises is composed of 30 grains of sulphur of antimony, and 60 grains of resin of jalap. He is against vomiting, and every thing that is of a heating nature.

MILE, a measure of length or distance, containing eight furlongs. The English statute-mile is 80 chains, or 1760 yards; that is, 5280 feet.

We shall here give a table of the miles in use among the principal nations of Europe, in geometrical paces, 60,000 of which make a degree of the equator.

	Geometrical paces.
Mile of Ruffia	750
of Italy	1000
of England	1200
of Scotland and Ireland	1500
Old league of France	1500
The small league, <i>ibid.</i>	2000
The mean league, <i>ibid.</i>	2500
The great league, <i>ibid.</i>	3000
Mile of Poland	3000
of Spain	3428
of Germany	4000
of Sweden	5000
of Denmark	5000
of Hungary	6000

MILETUS (anc. geogr.), a town of Crete mentioned by Homer; but where situated does not appear. It is said to be the mother-town of Miletus in Caria, whither a colony was led by Sarpedon, Minos's brother, (Ephorus, quoted by Strabo). *Milefsi*, the people, (Ovid).

MILETUS (anc. geogr.), the capital of Ionia, formerly a leading and principal town in the arts of war and peace, (Mela); of great antiquity, (Nonnus); built by Miletus the companion of Bacchus, (Apolodorus); famous above all for its colonies, (Herodotus, Strabo). The only town that made head against Alexander, and with much difficulty taken, (Arrian). The country of Thales, one of the seven wise men, and the first who applied himself to the study of nature. It was also the country of Anaximander, the scholar and successor of Thales, the inventor of sun-dials and the gnomon, and the first that published a geographical map; of Anaximenes, scholar and successor to the foregoing; and of other great men. It was famous for its excellent wool, according to Virgil. *Milefsi*, the people; who, from being powerful, becoming afterwards opulent and abandoned to pleasures, lost both their riches and their power.

MILFOIL, or YARROW. See ACHILLEA.

MILFORD-HAVEN, one of the finest harbours in Europe, and indubitably the best in Britain, is situated in Pembrokeshire in South-Wales, and lies on the north side of the Bristol Channel. It is very large, safe, and deep; there is no danger of going in or out with the tide, or almost with any wind. If a ship comes in without a cable or anchor, she may run ashore on the ooze, and there lie safe till she is refitted; and in an hour's time she may get out of the harbour into the open sea. It lies extremely convenient for ships bound from the English or Bristol Channels to Ireland, or farther west, and from thence to the Channels. It is said, that 1000 sail of any size may

Mile  
Mileford.

Milford  
Military.

ride secure in this haven. Yet Dr Campbell informs us, that, in some places, even this singular and wonderful haven is not safe. As, for instance, in Nangle-road, in Milford-haven, at about half-flood, all Nangle-flotch is covered; about the middle of which flotch or ooze there lie a parcel of straggling stones called the *Oyster-rocks*; most of them loose, and about four feet high, which renders the place very dangerous for ships which are obliged to run in there when it blows too hard in the road; and the more so, because they do not appear at low-water neap-tides, being quarter-tide stones. These, and some others on Nangle-point, may be removed at the expence of 100l.; but though the improvement and fortification of Milford-haven have been much talked of, and even a large sum granted by parliament for that purpose, very little hath been done, and it still continues in a great measure neglected. The pier, which lies now in ruins, would be very useful if repaired. In the time of queen Elizabeth, before the Spanish invasion, there were two forts begun at the entrance of Milford, one on each side, as may be seen in Speed's maps, called *Nangle* and *Dale Block-houses*; but they were never finished. The situation of these block-houses was very ill chosen, since a vessel being obliged to bring-to before she has well entered the mouth of the haven, may either drive ashore on the rocks, or miss the harbour. A small fort might be built on the Stack, and another on Sandy-haven Point, which would command the entrance of Milford-haven, and not be liable to the former objection, or in any way prejudice the shipping. Pennamouth is the opening of that branch of the haven upon which the town of Pembroke lies, where the custom-house of Milford is kept. The entrance, or breadth from rock to rock, is but 200 yards at high-water, and 112 at low-water, and from 9 to 12 feet deep. The navigation up this river to Pembroke-town is much impeded by the rubbish of the limestone-quarries being thrown into the river; which ought to be prevented, or the place will in time be stopped up. Within Pennamouth a dock might be made, which would contain all the shipping in England, and which would be the greatest thing of the kind in the whole world. Milford-haven contains five large bays, 13 good roads, and 16 safe creeks.

**MILINARY**, in general, something resembling millet-feed.

**MILINARY Fever**. See **MEDICINE**, n<sup>o</sup> 336.

**MILITANT**, or **CHURCH-MILITANT**, denotes the body of Christians while here on earth.

**MILITARY**, something belonging to the soldiery or militia.

**MILITARY-Discipline**, the training of soldiers, and the due enforcement of the laws and regulations instituted by authority for their conduct.

Next to the forming of troops, military discipline is the first object that presents itself to our notice: it is the soul of all armies; and unless it be established amongst them with great prudence, and supported with unshaken resolution, they are no better than so many contemptible heaps of rabble, which are more dangerous to the very state that maintains them, than even its declared enemies.

**MILITARY Execution**, the ravaging or destroying of

a country or town that refuses to pay the contribution Military. inflicted upon them.

**MILITARY-Exercise**. See **EXERCISE** and **WORDS of Command**.

**MILITARY-State**, in British polity, one of the three divisions of the laity. See **LAITY**.

This state includes the whole of the soldiery; or such persons as are peculiarly appointed among the rest of the people, for the safeguard and defence of the realm.

In a land of liberty, it is extremely dangerous to make a distinct order of the profession of arms. In absolute monarchies, this is necessary for the safety of the prince; and arises from the main principle of their constitution, which is that of governing by fear: but, in free states, the profession of a soldier, taken singly and merely as a profession, is justly an object of jealousy. In these no man should take up arms but with a view to defend his country and its laws: he puts not off the citizen when he enters the camp; but it is because he is a citizen, and would wish to continue so, that he makes himself for a while a soldier. The laws, therefore, and constitution of these kingdoms, know no such state as that of a perpetual standing soldier, bred up to no other profession than that of war: and it was not till the reign of Henry VII. that the kings of England had so much as a guard about their persons.

In the time of the Anglo-Saxons, as appears from Edward the confessor's laws, the military force of England was in the hands of the dukes or heretochs, who were constituted through every province and county in the kingdom; being taken out of the principal nobility, and such as were most remarkable for being *sapientes, fideles, et animosi*. Their duty was to lead and regulate the English armies, with a very unlimited power; *prout eis visum fuerit, ad honorem corone et utilitatem regni*. And because of this great power they were elected by the people in their full assembly, or folkmote, in the same manner as sheriffs were elected: following still that old fundamental maxim of the Saxon constitution, that where any officer was entrusted with such power, as, if abused, might tend to the oppression of the people, that power was delegated to him by the vote of the people themselves. So too, among the ancient Germans, the ancestors of our Saxon forefathers, they had their dukes, as well as kings, with an independent power over the military, as the kings had over the civil state. The dukes were elective, the kings hereditary: for so only can be consistently understood that passage of Tacitus, *Roges ex nobilitate, duces ex virtute sanant*. In constituting their kings, the family or blood-royal was regarded; in choosing their dukes or leaders, warlike merit just as Cæsar relates of their ancestors in his time, that whenever they went to war, by way either of attack or defence, they elected leaders to command them. This large share of power, thus conferred by the people, though intended to preserve the liberty of the subject, was perhaps unreasonably detrimental to the prerogative of the crown: and accordingly we find a very ill use made of it by Edric duke of Mercia, in the reign of king Edmond Ironside; who, by his office of duke or heretoch, was entitled to a large command in the king's army, and by his repeated treacheries



cheries at last transferred the crown to Canute the Dane.

It seems universally agreed by all historians, that king Alfred first settled a national militia in this kingdom, and by his prudent discipline made all the subjects of his dominion soldiers; but we are unfortunately left in the dark as to the particulars of this his fo celebrated regulation; though, from what was last observed, the dukes seem to have been left in possession of too large and independent a power: which enabled duke Harold on the death of Edward the confessor, though a stranger to the royal blood, to mount for a short space the throne of this kingdom, in prejudice of Edgar Atheling the rightful heir.

Upon the Norman conquest, the feudal law was introduced here in all its rigour, the whole of which is built on a military plan. In consequence thereof, all the lands in the kingdom were divided into what were called knights fees, in number above 60,000; and for every knight's fee a knight or soldier, *miles*, was bound to attend the king in his wars, for 40 days in a year; in which space of time, before war was reduced to a science, the campaign was generally finished, and a kingdom either conquered or victorious. By this means the king had, without any expence, an army of 60,000 men always ready at his command. And accordingly we find one, among the laws of William the conqueror, which in the king's name commands and firmly enjoins the personal attendance of all knights and others; *quod habeant et teneant se semper in armis et equis, ad decet et oportet: et quod semper sint prompti et parati ad servitium suum integrum nobis splendendum et peragendum, cum opus ad fuerit, secundum quod debent de feodis et tenementis suis de jure nobis facere.* This personal service in process of time degenerated into pecuniary commutations or aids; and at last the military part of the feudal system was abolished at the Restoration, by statute 12 Cor. II. c. 24. See FEUDAL System.

In the mean time we are not to imagine that the kingdom was left wholly without defence in case of domestic insurrections, or the prospect of foreign invasions. Besides those who by their military tenures were bound to perform 40 days service in the field, first the assise of arms, enacted 27 Hen. II. and afterwards the statute of Winchester, under Edward I. obliged every man, according to his estate and degree, to provide a determinate quantity of fish arms as were then in use, in order to keep the peace; and constables were appointed in all hundreds by the latter statute, to see that such arms were provided. These weapons were changed, by the statute 4 & 5 Ph. & M. c. 2. into others of more modern service; but both this and the former provisions were repealed in the reign of James I. While these continued in force, it was usual from time to time for our princes to issue commissions of array, and send into every county officers in whom they could confide, to muster and array (or set in military order) the inhabitants of every district; and the form of the commission of array was settled in parliament in the 5 Hen. IV. But at the same time it was provided, that no man should be compelled to go out of the kingdom at any rate, nor out of his shire, but in cases of urgent necessity; nor should provide soldiers unless by consent of parliament. About the reign of king Henry VIII.

and his children, lord-lieutenants began to be introduced, as standing representatives of the crown, to keep the counties in military order; for we find them mentioned as known officers in the statute 4 & 5 Ph. & M. c. 3. tho' they had not been then long in use; for Camden speaks of them in the time of queen Elizabeth as extraordinary magistrates, constituted only in times of difficulty and danger.

In this state things continued till the repeal of the statutes of armour in the reign of king James I.; after which, when king Charles I. had, during his northern expeditions, issued commissions of lieutenancy, and exerted some military powers which, having been long exercised, were thought to belong to the crown, it became a question in the long-parliament, how far the power of the militia did inherently reside in the king; being now unsupported by any statute, and founded only upon immemorial usage. This question, long agitated with great heat and resentment on both sides, became at length the immediate cause of the fatal rupture between the king and his parliament: the two houses not only denying this prerogative of the crown, the legality of which claim perhaps might be somewhat doubtful; but also seizing into their hands the entire power of the militia, the illegality of which step could never be any doubt at all.

Soon after the restoration of king Char. II. when the military tenures were abolished, it was thought proper to ascertain the power of the militia, to recognize the sole right of the crown to govern and command them, and to put the whole into a more regular method of military subordination: and the order in which the militia now stands by law, is principally built upon the statutes which were then enacted. It is true, the two last of them are apparently repealed; but many of their provisions are re-enacted, with the addition of some new regulations, by the present militia-laws: the general scheme of which is to discipline a certain number of the inhabitants of every county, chosen by lot for three years, and officered by the lord-lieutenant, the deputy-lieutenants, and other principal landholders, under a commission from the crown. They are not compellable to march out of their counties, unless in case of invasion or actual rebellion, nor in any case compellable to march out of the kingdom. They are to be exercised at stated times: and their discipline in general is liberal and easy; but, when drawn out into actual service, they are subject to the rigours of martial law, as necessary to keep them in order. This is the constitutional security which our laws have provided for the public peace, and for protecting the realm against foreign or domestic violence; and which the statutes declare is essentially necessary to the safety and prosperity of the kingdom.

When the nation was engaged in war, more veteran troops and more regular discipline were cited to be necessary, than could be expected from a mere militia; and therefore at such times more rigorous methods were put in use for the raising of armies and the due regulation and discipline of the soldiery: which are to be looked upon only as temporary excrescences bred out of the disemper of the state, and not as any part of the permanent and perpetual laws of the kingdom. For martial law, which is built upon no settled principles, but is entirely arbitrary in its decisions, is,

Military.

as Sir Matthew Hale observes, in truth and reality no law, but something indulged rather than allowed as a law. The necessity of order and discipline in an army is the only thing which can give it countenance; and therefore it ought not to be permitted in time of peace, when the king's courts are open for all persons to receive justice according to the laws of the land. Wherefore, Thomas earl of Lancaster being conducted at Pontefract, 15 Edw. II. by martial law, his attainder was reversed 1 Edw. III. because it was done in time of peace. And it is laid down, that if a lieutenant, or other, that hath commission of martial authority, doth in time of peace hang or otherwise execute any man by colour of martial law, this is murder; for it is against *magna carta*. And the petition of right enacts, that no soldier shall be quartered on the subject without his own consent; and that no commission shall issue to proceed within this land according to martial law. And whereas, after the Restoration, king Ch. II. kept up about 5000 regular troops, by his own authority, for guards and garrisons; which king James II. by degrees increased to no less than 30,000, all paid from his own civil list; it was made one of the articles of the bill of rights, that the raising or keeping a standing army within the kingdom in time of peace, unless it be with consent of parliament, is against law.

But as the fashion of keeping standing armies (which was first introduced by Charles VII. in France, 1445) has of late years universally prevailed over Europe, (tho' some of its potentates, being unable themselves to maintain them, are obliged to have recourse to richer powers, and receive subsidiary pensions for that purpose), it has also for many years past been annually judged necessary by our legislature, for the safety of the kingdom, the defence of the possessions of the crown of Great Britain, and the preservation of the balance of power in Europe, to maintain even in time of peace a standing body of troops, under the command of the crown; who are however *ipso facto* disbanded at the expiration of every year, unless continued by parliament. And it was enacted by statute 10 W. III. c. 1. that not more than 12,000 regular forces should be kept on foot in Ireland, tho' paid at the charge of that kingdom: which permission is extended by stat. 8. Geo. III. c. 13. to 16,235 men in time of peace.

To prevent the executive power from being able to oppress, says baron Montequieu, it is requisite that the armies with which it is entrusted should consist of the people, and have the same spirit with the people; as was the case at Rome, till Marius new-modelled the legions by enlisting the rabble of Italy, and laid the foundation of all the military tyranny that ensued. Nothing then, according to these principles, ought to be more guarded against in a free state, than making the military power, when such a one is necessary to be kept on foot, a body too distinct from the people. Like ours, therefore, it should wholly be composed of natural subjects; it ought only to be enlisted for a short and limited time; the soldiers also should live intermixed with the people; no separate camp, no barracks, no inland fortresses should be allowed. And perhaps it might be still better, if, by dismissing a stated

Military.

number, and enlisting others at every renewal of the term, a circulation could be kept up between the army and the people, and the citizen and the soldier be more intimately connected together.

To keep this body of troops in order, an annual act of parliament likewise passes, "to punish mutiny and desertion, and for the better payment of the army and their quarters." This regulates the manner in which they are to be dispersed among the several inn-keepers and victuallers throughout the kingdom; and establishes a law-martial for their government. By this, among other things, it is enacted, that if any officer or soldier shall excite, or join any mutiny, or, knowing of it, shall not give notice to the commanding officer, or shall desert, or lift in any other regiment, or sleep upon his post, or leave it before he is relieved, or hold correspondence with a rebel or enemy, or strike or use violence to his superior officer, or shall disobey his lawful commands; such offender shall suffer such punishment as a court-martial shall inflict, tho' it extend to death itself.

However expedient the most strict regulations may be in time of actual war, yet, in times of profound peace, a little relaxation of military rigour would not, one should hope, be productive of much inconvenience. And, upon this principle, tho' by our standing laws (still remaining in force, tho' not attended to) desertion in time of war is made felony without benefit of clergy, and the offence is triable by a jury and before the judges of the common law; yet, by our militia-laws beforementioned, a much lighter punishment is inflicted for desertion in time of peace. So, by the Roman law also, desertion in time of war was punished with death, but more mildly in time of tranquillity. But our mutiny-act makes no such distinction: for any of the faults abovementioned are, equally at all times, punishable with death itself, if a court-martial shall think proper. This discretionary power of the court-martial is indeed to be guided by the directions of the crown; which, with regard to military offences, has almost an absolute legislative power. "His Majesty (says the act) may form articles of war, and constitute courts-martial, with power to try any crime by such articles, and inflict such penalties as the articles direct." A vast and most important trust! an unlimited power to create crimes, and annex to them any punishments not extending to life or limb! These are indeed forbidden to be inflicted, except for crimes declared to be so punishable by this act; which crimes we have just enumerated, and among which, we may observe, that any disobedience to lawful commands is one. Perhaps in some future revision of this act, which is in many respects hastily penned, it may be thought worthy the wisdom of parliament to ascertain the limits of military subjection, and to enact express articles of war for the government of the army, as is done for the government of the navy: especially as, by our present constitution, the nobility and gentry of the kingdom, who serve their country as militia officers, are annually subjected to the same arbitrary rule during their time of exercise.

One of the greatest advantages of our law is, that not only the crimes themselves which it punishes, but also the penalties which it inflicts, are ascertained and no-

no-

**Military, notorious** : nothing is left to arbitrary discretion : the king by his judges dispenses what the law has previously ordained ; but is not himself the legislator. How much therefore is it to be regretted, that a set of men, whose bravery has so often preserved the liberties of their country, should be reduced to a state of servitude in the midst of a nation of freemen ! for Sir Edward Coke will inform us, that it is one of the genuine marks of servitude, to have the law, which is our rule of action, either concealed or precarious : *Miseræ est servituti, ubi jus est vagum aut incognitum.* Nor is this state of servitude quite consistent with the maxims of sound policy observed by other free nations.

**Black's Comment.**

For the greater the general liberty is which any state enjoys, the more cautious has it usually been in introducing slavery in any particular order or profession. These men, as baron Montesquieu observes, seeing the liberty which others possess, and which they themselves are excluded from, are apt (like cunuchs in the eastern seraglios) to live in a state of perpetual envy and hatred towards the rest of the community, and indulge a malignant pleasure in contributing to destroy those privileges to which they can never be admitted. Hence have many free states, by departing from this rule, been endangered by the revolt of their slaves : while, in absolute and despotic governments, where no real liberty exists, and consequently no invidious comparisons can be formed, such incidents are extremely rare. Two precautions are therefore advised to be observed in all prudent and free governments : 1. To prevent the introduction of slavery at all : or, 2. If it be already introduced, not to entrust those slaves with arms ; who will then find themselves an overmatch for the freemen. Much less ought the soldiery to be an exception to the people in general, and the only state of servitude in the nation.

But as soldiers, by this annual act, are thus put in a worse condition than any other subjects ; so, by the humanity of our standing laws, they are in some cases put in a much better. By statute 43 Eliz. c. 3, a weekly allowance is to be raised in every county for the relief of soldiers that are sick, hurt, and maimed : not forgetting the royal hospital at Chelsea for such as are worn out in their duty. Officers and soldiers, that have been in the king's service, are by several statutes, enacted at the close of several wars, at liberty to use any trade or occupation they are fit for, in any town in the kingdom (except the two universities), notwithstanding any statute, custom, or charter to the contrary. And soldiers in actual military service may make nuncupative wills, and dispose of their goods, wages, and other personal chattels, without these forms, solemnities, and expences, which the law requires in other cases. Our law does not indeed extend this privilege so far as the civil law, which carried it to an extreme that borders upon the ridiculous : for if a soldier, in the article of death, wrote any thing in bloody letters on his shield, or in the dust of the field with his sword, it was a very good military testament.

**MILITARY COURT.** See CHIVALRY (Court of).

**MILITARY TENURES.** See TENURE, FEODAL SYSTEM, and KNIGHT.

**MILITIA**, in general, denotes the body of soldiers, or those who make profession of arms.

In a more restrained sense, militia denotes the trained bands of a town or country, who arm themselves, upon a short warning, for their own defence. So that, in this sense, militia is opposed to regular or stated troops. See **MILITARY STATE**, and **FEODAL SYSTEM**.

**MILIUUM, MILLET**, a genus of the digynia order, belonging to the triandria class of plants. There are five species, of which the most remarkable is the panicum or common millet. This is a native of India, but is now commonly cultivated in many parts of Europe as an esculent grain. It rises, with a reed-like stalk, three or four feet high, and channelled : at every joint there is one reed-like leaf, which is joined on the top of the sheath, and embraces and covers that joint of the stalk below the leaf : this sheath is closely covered with soft hairs, but the leaf which is expanded has none. The top of the stalk is terminated by a large loose panicle, which hangs on one side, having a chaffy flower, which is succeeded by a small round seed. There are two varieties ; one with white, and the other with black seeds ; but they do not differ in any other particular. This plant is greatly cultivated in the oriental countries, and from whence we are annually furnished with it. It is seldom cultivated in Britain but in small gardens, for feeding of poultry, where the seeds generally ripen very well. It is used as an ingredient in puddings, and is by some people greatly esteemed. The seeds must be sown in the beginning of April, upon a warm dry soil, but not too thick, because the plants divide into several branches, and should have much room. When they come up they should be cleared from weeds ; after which they will in a short time get the better of them, and prevent the future growth. In August the seeds will ripen, when the plant must be cut down, and the seeds beaten out as is practised for other grain ; but if it is not protected from birds, they will devour it as soon as it begins to ripen.

**MILK**, a well-known fluid, prepared by nature in the breasts of women, and the udders of other animals, for the nourishment of their young.—According *Leff. on Med. Med.* to Dr. Cullen, milk is a connecting and intermediate substance between animals and vegetables. It seems immediately to be secreted from the chyle, both being a white liquor of the same consistence : it is most copiously secreted after meals, and of an acceftent nature. In most animals who live on vegetables, the milk is acceftent ; and it is uncertain, though at the same time no observation proves the contrary, whether it is not so likewise in carnivorous animals. But, whatever be in this, it is certain, that the milk of all animals who live on vegetables is acceftent. Milk being derived from the chyle, we thence conclude its vegetable nature ; for in those who live on both profusively, more milk is got, and more quickly, from the vegetable than the animal food. Milk, however, is not purely vegetable ; though we have a vegetable liquor that resembles its taste, consistence, colour, acceftency, and the separability of the oily part, viz. an emulsion of the nuceæ oleosæ and farinaceous substances. But these want the coagulable part of milk, which seems to be of animal-nature, approaching to that of the coagulable lymph of the blood. Milk, then, seems to be of an intermediate nature, between chyle taken up

**Milium, Milk.**

up from the intestines and the fully elaborated animal-fluid.

Its contents are of three kinds: first, an oily part, which, whatever may be said concerning the origin of other oils in the body, is certainly immediately derived from the oil of the vegetables taken in, as with these it agrees very exactly in its nature, and would entirely if we could separate it fully from the coagulable part. Another mark of their agreement is the separability, which proves that the mixture has been lately attempted, but not fully performed. 2dly, Besides this oily, there is a proper coagulable part: And, 3dly, Much water accompanies both, in which there is dissolved a saline saccharine substance. These three can be got separate in cheese, butter, and whey; but never perfectly so, a part of each being always blended with every other part.

Nothing is more common, from what has been said of its immediate nature, than to suppose that it requires no assimilation; and hence has been deduced the reason of its exhibition in the most weakly state of the human body. But wherever we can examine milk, we always find that it coagulates, suffers a decomposition, and becomes acedent. Again, infants, who feed entirely on milk, are always troubled with eructations, which every body observes are not of the same quality with the food taken; and therefore it appears, that, like all other food, milk turns naturally acedent in the stomach, and only enters the chyle and blood in consequence of a new recombination. It approaches then to the nature of vegetable aliment, but is not capable of its noxious vinous fermentation, and therefore has an advantage over it; neither from this quality, like animal-food, is it heating in the stomach, and productive of fever; though at the same time, from its quantity of coagulable matter, it is more nourishing than vegetables.

Milk is the food most universally suited to all ages and states of the body; but it seems chiefly designed by nature as the food of infants. When animals are in the fetus-state, their solids are a perfect jelly, incapable of an assimilatory power. In such state nature has perfectly assimilated food, as the albumen ovi in the oviparous, and in the viviparous animals certainly somewhat of the same kind, as it was necessary the vessels should be filled with such a fluid as would make way for an after-assimilation. When the infant has attained a considerable degree of firmness, as when it is separated from the mother, yet such a degree of weakness still remains as makes somewhat of the same indication necessary, it behoves the infant to have an alkaliescent food ready prepared, and at the same time its noxious tendency to be avoided. Milk then is given, which is alkaliescent, and, at the same time, has a sufficient quantity of acidity to correct that alkaliescenty. As the body advances in growth, and the alkaliescent tendency is greater, the animal, to obviate that tendency, is led to take vegetable food, as more suited to its strength of assimilation.

Dr Cullen observes, that milk is almost suited to all temperaments; and it is even so to stomachs disposed to acedency, more than those substances which have undergone the vinous fermentation; nay, it even cures the heart-burn, checks vinous fermentation, and precipitates the lees, when, by renewal of fermentation,

the wine happens to be fouled. It therefore very properly accompanies a great deal of vegetable aliment; although sometimes its acedency is troublesome, either from a large proportion taken in, or from the degree of it; for, according to certain unaccountable circumstances, different acids are formed in the stomach in different states of the body; in a healthy body, *e. g.* a mild one; in the hypochondriac disease, one sometimes as corrosive as the fossil acid. When the acidity of milk is carried to a great degree, it may prove remarkably refrigerant, and occasion cold crudities, and the recurrence of intermittent fevers. To take the common notion of its passing unchanged into the blood, it can suffer no solution. But if we admit its coagulum in the stomach, then it may be reckoned among soluble or insoluble foods, according as that coagulum is more or less tenacious. Formerly rennet, which is employed to coagulate milk, was thought an acid; but, from late observations, it appears, that, if it be an acid, it is very different from other acids, and that its coagulum is stronger than that produced by acids. It has been imagined, that a rennet is to be found in the stomachs of all animals, which causes coagulation of milk; but, to Dr Cullen, the coagulation of milk seems to be owing to a weak acid in the stomach, the relicts of our vegetable food, inducing, in healthy persons, a weak and soluble coagulum; but in different stomachs this may be very different, in these becoming heavy and less soluble food, and sometimes even evacuated in a coagulated undissolved state both by stomach and stool.

As milk is acedent, it may be rendered sometimes purgative by mixing with the bile; and some examples of this have been remarked. More commonly, however, it is reckoned among those foods which occasion costiveness.

Hoffman, in his experiments on milk, found that all kinds of it contained much water; and when this was dissipated, found the residuum very different in their solubility. But we must not thence conclude, that the same insolubility takes place in the stomach; for extracts made from vegetables with water are often very insoluble substances, and hardly diffusible through water itself: therefore, in Hoffman's extracts, if we may so call them, of milk, somewhat of the same kind might have appeared; and these substances, which in their natural state were not so, might appear very insoluble. However, we may allow that milk is always somehow insoluble in the intestines, as it is of a drying nature, and, as cheese, &c. is very colive. And this effect shows that milk is always coagulated in the stomach; for if it remained fluid, no feces would be produced, whereas sometimes very hard ones are observed. In the blood-vessels, from its animal-nature, it may be considered as nutritious; but when we consider its vegetable contents, and acedency in the prime vie, we find, that, like animal-food, it does not excite that degree of fever in the time of digestion, and that from its acedency it will resist putrefaction. Hence its use in hectic fevers, which, whatever be their cause, appear only to be exacerbations of natural feverish paroxysms, which occur twice every day, commonly after meals, and at night. To obviate these, therefore, we give such an aliment as produces the least exacerbation of these fevers; and of this nature is milk,

Milk. on account of its acefcent vegetable nature.

There appears alfo somewhat peculiar to milk, which requires only a fmall exertion of the animal-powers in order to its affimilation; and beſides, in hectic complaints there is wanted an oily, bland food, approaching to the animal-nature: fo that on all theſe accounts, milk is a diet peculiarly adapted to them, and, in general, to moſt convalefcents, and to thoſe of inflammatory temperaments.—So far of milk in general.—We ſhall now ſpeak of the particular kinds which are in common uſe.

The milk of women, mares, and aſſes, agree very much in their qualities, being very dilute, having little ſolid contents, and, when evaporated to dryneſs, having theſe very ſoluble, containing much ſaccharine matter, of a very ready acefcency, and, when coagulated, their coagulum being tender and eaſily broke down. From this view they have leſs oil, and ſeem to have leſs coagulable matter, than the reſt.

The milk of cows, ſheep, and goats, agree, in oppoſite qualities to the three juſt mentioned; but here there is ſomewhat more of gradation. Cows milk comes neareſt to the former milk: goats milk is leſs fluid, leſs ſweet, leſs flatulent, has the largeſt proportion of iſoluble part after coagulation, and indeed the largeſt proportion of coagulable part; its oily and coagulable parts are not ſpontaneouſly ſeparable, never throwing out a cream, or allowing butter to be readily extracted from it. Hence the virtues of theſe milks are obvious, being more nourishing, though, at the ſame time, leſs eaſily ſoluble in weak ſtomachs, than the three firſt, leſs acefcant than theſe, and fo more rarely laxative, and peculiarly fitted for the diet of convaleſcents without fever. The three firſt, again, are leſs nourishing, more ſoluble, more laxative, as more acefcant, and adapted to the convaleſcents with fever.

Theſe qualities, in particular milks, are conſiderably diverſified by different circumſtances. Firſt, Different animals, living on the ſame diet, give a conſiderably different milk; for there ſeems to be ſomething in the conſtitution, abſtracting from the aliment, which conſtitutes a conſiderable diverſity of milk, not only in the ſame ſpecies of animals, but alſo in the ſame animal, at different ages, and at different diſtances after delivery: this applies to the choice of nurſes. Secondly, Milk follows the nature of the aliment more than any other juice in the human body, being more or leſs fluid and dilute, more or leſs ſolid and nourishing, in proportion as theſe qualities are more or leſs in the aliment. The nature of the aliment differs according to its time of growth, *e. g.* old graſs being always found more nourishing than young. Aliment, too, is always varied according to the ſeaſon, as that is warm or dry, moiſt or cloudy.

The milk of each particular kind of animal is fitted for particular purpoſes, when fed on proper food. Thus the cow delights in the ſucculent herbage of the vale: if the ſheep be fed there he certainly rots, but on the higher and more dry ſide of the mountain he feeds pleaſantly and healthy: while the goat never ſtops near the bottom, but aſcends to the craggy ſummit: and certainly the milks of theſe animals are always beſt on their proper ſoil, and that of goats is beſt

on a mountainous country. From a diſſertation of Linnæus, we have many obſervations concerning the diverſity of plants on which each animal chooſes to feed. All the Swediſh plants which could be collected together, were preſented alternately to domeſtic animals, and then it appeared that the goat lived on the greateſt variety, and even on many which were poiſonous to the reſt; that the cow choſe the firſt ſucculent ſhoots of the plant, and neglected the fruſtrification; which laſt was preferred by the goat. Hence may be deduced rules concerning the paſſage of different animals; *e. g.* Farmers find, that, in a paſture which was only fit to feed a certain number of ſheep, an equal number of goats may be introduced, while the ſheep are no leſs nourished than before.

It is not eaſy to aſſign the difference between milk freſh-drawn and that detained in the open air for ſome time; but certainly there is ſome material one, otherwiſe nature univerſally would not have directed infants to ſuckling; and indeed it ſeems, better than the other, fitted for digeſtion and nourishment. Phyſicians have ſuppoſed that this depended on the evaporation of ſome *ſpi. reſcor.* but our author cannot conceive any ſuch, except common water here; and beſides, theſe volatile parts can hardly be nutritious. A more plauſible account ſeems deducible from mixture: milk, new drawn, has been but lately mixed, and is expoſed to ſpontaneous ſeparation, a circumſtance hurtful to digeſtion; none of the parts being, by themſelves, ſo eaſily affimilated as when they are all taken together. Hence, then, milk new-drawn is more intimately blended, and therefore then is moſt proper to the weakly and infants.

Another difference in the uſe of milk expoſed for ſome time to the air, is taking it boiled or unboiled. Phyſicians have generally recommended the former; but the reaſon is not eaſily aſſigned. Perhaps it is this: Milk kept for ſome time, expoſed to the air has gone ſo far to a ſpontaneous ſeparation; whereas the heat thoroughly blends the whole, and hence its reſolution is not ſo eaſy in the ſtomach; and thus boiled milk is more coſtive than raw, and gives more feces. Again, when milk is boiled, a conſiderable quantity of air is detached, as appears from the froth on the ſurface; and air is the chief inſtrument of fermentation in bodies; ſo that, after this proceſs, it is not liable to acefcency: for theſe reaſons it is proper for the robuſt and vigorous.

Another difference of milk is, according as it is fluid or coagulated. The coagulated is of two kinds, as induced by rennet, or the natural acefcency of the milk. The former preparation makes the firmer and leſs eaſily ſoluble coagulum; though, when taken with the whey unſeparated, it is leſs difficult of ſolution, tho' more ſo than any other coagulum in the ſame caſe. Many nations uſe the latter form, which is eaſier ſoluble, but very much acefcant, and therefore; in point of ſolution, ſhould be confined to the vigorous, in point of acefcency, to thoſe who live on alkaleſcent food; and in the laſt caſe the Laplanders uſe it as their chief acefcant condiment. From the ſame conſiderations it is more cooling, and in its other effects like all other acefcant vegetables.

Milk.

Milk by evaporation yields a sweet saline matter, of which Dr Lewis gives the following proportions:

Twelve ounces of	Left of dry matter	From which water extracted a sweet saline substance amounting to
Cows milk	13 drams.	1½ drams.
Goats milk	12½	1½
Human milk	8	6
Asses milk	8	6

The saline substance extracted from asses milk was white, and sweet as sugar; that of the others brown, or yellow, and considerably less sweet; that from cows milk had the least sweetness of any.

On distilling 12 quarts of milk in *balneo marie*, at least nine quarts of pure phlegm were obtained: the liquor which afterwards arose was acidulous, and by degrees grew sensibly more and more acid as the distillation was continued. After this came over a little spirit, and at last an empyreumatic oil. The remaining solid matter adhered to the bottom of the retort; in the form of elegant shining black flowers, which being calcined and elixated yielded a portion of fixed alkaline salt.

Milk, set in a warm place, throws up to the surface an unctuous cream, from which, by agitation, the butter is easily separated. The addition of alkaline salts prevents this separation, not (as some have supposed) by absorbing an acid from the milk, but by virtue of their property of intimately uniting oily bodies with watery liquors. Sugar, another grand intermedium betwixt oils and water, has this effect in a greater degree, though that concrete is by no means alkaline, or an absorbent of acids.

The sweet saccharine part of the milk remains dissolved in the whey after the separation of the curd or cheesy matter, and may be collected from it in a white crystalline form, by boiling the whey till all remains of the curdled substance have fallen to the bottom; then filtering, evaporating it to a due consistence, setting it to shoot, and purifying the crystals by solution in water and a second crystallization. Much has been said of the medicinal virtues of this sugar of milk; but it does not seem to have any considerable ones: It is from cows milk that it has been generally prepared; and the crystals obtained from this kind of milk have but little sweetness.

When milk is suffered to coagulate spontaneously, the whey proves acid, and on standing grows more and more so till the putrefactive state commences. Sour whey is used as an acid, preferably to the directly vegetable or the mineral acids, in some of the chemical arts; as for dissolving iron in order to the staining of linen and leather. This acid was commonly made use of in the bleaching of linen, for dissolving and extracting the earthy particles left in the cloth by the alkaline salts and lime employed for cleansing and whitening it. Butter-milk is preferred to plain four-milk or four-whey: This last is supposed to give the cloth a yellow colour. Dr Home, in his ingenious treatise on this subject, recommends water acidulated with spirit of vitriol, (in the proportion of about half an ounce, or at most three quarters of an ounce, to a gallon), as preferable in many respects to the acid of

Milk.

milk, or of the more directly vegetable substances. He observes, that the latter are often difficultly procurable, abound with oleaginous particles, and hasten to corruption; whilst the vitriolic acid is cheap, and pure, and indisposed to putrefy: That milk takes five days to perform its office, whilst the vitriolic acid does it in as many hours, perhaps in as many minutes: That this acid contributes also to whiten the cloth, and does not make it weaker though the cloth be kept in it for months. He finds, that acids as well as alkalis, extract an oily matter from the cloth, and lose their acidity and alkalicity. Since this treatise appeared, the use of four-milk is very generally superseded by oil of vitriol.

It is observable, that asses milk is greatly disposed, on standing for a little time, to become thick andropy. In the Bressau collection for the year 1720, there is a remarkable account of milk (which probably was that of the ass) grown so thick and tenacious as to be drawn out into long strings, which, when dried, were quite brittle.

New cows milk, suffered to stand for some days on the leaves of butterwort or sun-dew, becomes uniformly thick, slippery, and coherent, and of an agreeable sweet taste, without any separation of its parts. Fresh milk, added to this, is thickened in the same manner, and this successively. In some parts of Sweden, as we are informed in the Swedish Memoirs, milk is thus prepared for food.

New milk has a degree of glutinous quality, so as to be used for joining broken stone-ware. There is a far greater tenacity in cheese properly prepared.

Milk, when examined by a microscope, appears composed of numerous globules swimming in a transparent fluid. It boils in nearly the same degree of heat with common water; some forts rather sooner, and some a little later: after boiling, it is less disposed to grow four than in its natural state. It is coagulated by acids both mineral and vegetable, and by alkalis both fixed and volatile. The coagulum made by acids falls to the bottom of the serum; that made by alkalis swims on the surface, commonly forming (especially with volatile alkalis) a thick coriaceous skin. The serum, with alkalis, proves green or fannous; with acids, it differs little in appearance from the whey that separates spontaneously. The coagulum formed by acids is dissolved by alkalis, and that formed by alkalis is re-dissolved by acids; but the milk does not in either case resume its original properties. It is coagulated by most of the middle salts, whose basis is an earth or a metallic body; as solution of alum, fixed sal ammoniac, sugar of lead, green and blue vitriol: but not by the chalybeate or purging mineral waters, nor by the bitter salt extracted from the purging waters. Among the neutral salts that have been tried, there is not one that produces any coagulation. They all dilute the milk, and make it less disposed to coagulate with acids or alkalis: Nitre seems to have this effect in a greater degree than the other neutral salts. It is instantly coagulated by highly-rectified spirit of wine, but scarcely by a phlegmatic spirit. It does not mingle with expressed oils. All the coagula are dissolved by gall.

Milk of Lime. Milk of Sulphur. The name of milk is given to substances very different from milk properly

so called, and which resemble milk only in colour. Such is water in which quicklime has been slaked, which acquires a whiteness from the small particles of the lime being suspended in it, and has hence been called the *milk of lime*. Such also is the solution of liver of sulphur, when an acid is mixed with it, by which white particles of sulphur are made to float in the liquor.

*Milk of Vegetables.* For the same reason that milk of animals may be considered as a true animal-emulsion, the emulsive liquors of vegetables may be called *vegetable milks*. Accordingly emulsions made with almonds are commonly called *milk of almonds*. But besides this vegetable milk, which is in some measure artificial, many plants and trees contain naturally a large quantity of emulsive or milky juices. Such are lettuce, spurge, fig-tree, and the tree which furnishes the elastic American resin. The milky juices obtained from all these vegetables derive their whiteness from an oily matter, mixed and undissolved in a watery or mucilaginous liquor. Most resinous gums were originally such milky juices, which afterwards become solid by the evaporation of their most fluid and volatile parts.

These natural milky juices have not been examined by any chemist. Such an examination would, however, procure much essential knowledge concerning vegetable economy. We should probably find examples of all kinds of oils reduced into milky juices; and this knowledge cannot fail of throwing much light on the nature of resins and gum-resins.

*MILK-Fever.* See MIDWINTER, Chap. XX.

**MILL**, a machine for grinding corn, &c. of which there are various kinds, according to the different methods of applying the moving power; as water-mills, wind-mills, mills worked by horses, &c. See MECHANICS.

The first obvious method of reducing corn into flour for bread would be, by the simple expedient of pounding. And that was for ages the only one which was practised by the various descendants of Adam, and actually continued in use among the Romans below the reign of Vespasian. But the process was very early improved by the application of a grinding power, and the introduction of mill-stones. This, like most of the common refinements in domestic life, was probably the invention of the antediluvian world, and certainly practised in some of the earliest ages after it. And, like most of them, it was equally known in the east and west. Hence the Gauls and Britons appear familiarly acquainted with the use of hand-mills before the time of their submission to the Romans; the Britons particularly distinguishing them, as the Highlanders and we distinguish them at present, by the simple appellation of *querns, carnes, or stones*. And to these the Romans added the very useful invention of water-mills. For this discovery the world is pretty certainly indebted to the genius of Italy; and the machine was not uncommon in the country at the conquest of Lancashire. This, therefore, the Romans would necessarily introduce with their many other refinements among us. And that they actually did, the British appellation of a *water-mill* fully suggests of itself; the *melin* of the Welsh and Cornish, the *mull, meill, and melin* of the Armoricians, and the Irish *millean* and *millind*, being all evidently de-

derived from the Roman *mola* and *molinendum*. The subject Britons universally adopted the Roman name, but applied it, as we their successors do, only to the Roman mill; and one of these was probably erected at every stationary city in the kingdom. One plainly was at Manchester, serving equally the purposes of the town, and the accommodation of the garrison. And one alone would be sufficient, as the use of hand-mills remained very common in both, many having been found about the site of the station particularly; and the general practice having descended among us nearly to the present period. Such it would be peculiarly necessary to have in the camp, that the garrison might be provided against a siege. And the water-mill at Manchester was fixed immediately below the Castle-field and the town, and on the channel of the Medlock. There, a little above the ancient ford, the sluice of it was accidentally discovered about 30 years ago. On the margin of Dyer's-croft, and opposite to some new constructions, the current of the river, accidentally swelled with the rains, and, obstructed by a dam, broke down the northern bank, swept away a large oak upon the edge of it, and disclosed a long tunnel in the rock below. This has been since laid open in part with a spade. It appeared entirely uncovered at the top, was about a yard in width, and another in depth, but gradually narrowed to the bottom. The sides shewed every-where the marks of the tool on the rock, and the course of it was parallel with the channel. It was bared by the flood about 25 yards only in length, but was evidently continued for several further; having originally begun, as the nature of the ground evinces, just above the large curve in the channel of the Medlock.

For the first five or six centuries of the Roman state, there were no public bread-bakers in the city of Rome. They were first introduced into it from the east, at the conclusion of the war with Perseus, and about the year 167 before Christ. And, towards the close of the first century, the Roman families were supplied by them every morning with fresh loaves for breakfast. But the same custom, which prevailed originally among the Romans and many other nations, has continued nearly to the present time among the Mancunians. The providing of bread for every family was left entirely to the attention of the women in it. And it was baked upon stones, which the Welsh denominate *greiddols* and we *greddles*. It appears, however, from the kiln-burnt pottery which has been discovered in the British sepulchres, and from the British appellation of an *odyn* or *oven* remaining among us at present, that furnaces for baking were generally known among the original Britons. An *odyn* would, therefore, be erected at the mansion of each British baron, for the use of himself and his retainers. And, when he and they removed into the vicinity of a Roman station, the oven would be rebuilt with the mansion, and the public bakehouses of our towns commence at the first foundation of them. One bakehouse would be constructed, as we have previously shewn one mill to have been set up, for the public service of all the Mancunian families. One oven and one mill appear to have been equally established in the town. And the inhabitants of it appear immemorially accustomed to bake at the one and grind at the other. Both, therefore, were in all pro-

Whitaker's  
Hist. of  
Manchester.

bability constructed at the first introduction of water-mills and ovens into the country. The great similarity of the appointments refers the consideration directly to one and the same origin for them. And the general nature of all such institutions points immediately to the first and actual introduction of both. And, as the same establishments prevailed equally in other parts of the north, and pretty certainly obtained over all the extent of Roman Britain, the same erections were as certainly made at every stationary town in the kingdom.

MILL (John), a very learned divine, was born at Shap in Westmoreland, about the year 1645; and became a fervitor of Queen's college Oxford. On his entering into orders he became an eminent preacher, and was made prebendary of Exeter. In 1681, he was created doctor of divinity; about the same time he was made chaplain in ordinary to king Charles II. and in 1685 he was elected principal of St Edmund's hall in Oxford. His edition of the Greek Testament, which will ever render his name memorable, was published about a fortnight before his death, which happened in June 1707. Dr Mill was employed 30 years in preparing this edition.

MILLENARIANS, or CHILIASTS, a name given to those, in the primitive ages, who believed that the saints will reign on earth with Christ 1000 years.

The Millenarians held, that after the coming of Antichrist, and the destruction of all nations which shall follow, there shall be a first resurrection of the just alone: that all who shall be buried upon earth, both good and bad, shall continue alive; the good, to obey the just who are risen, as their princes; the bad, to be conquered by the just, and to be subject to them: that Jesus Christ will then descend from heaven in his glory: that the city of Jerusalem will be rebuilt, enlarged, embellished, and its gates stand open night and day. They applied to this new Jerusalem what is said in the Apocalypse, chap. xxi. and to the temple all that is written in Ezekiel xxxvi. Here, they pretended, Jesus Christ will fix the seat of his empire, and reign 1000 years with the saints, patriarchs, and prophets, who will enjoy perfect and uninterrupted felicity.

This reign of our Saviour on earth is usually styled the *millennium*, or reign of 1000 years.

MILLEPES, or WOOD LOUSE, in zoology; a species of *ONISCUS*. These insects are found in cellars, under stones, and in cold moist places; in the warmer countries they are rarely met with. Milleepedes have a faint disagreeable smell, and a somewhat pungent, sweetish, nauseous taste. They have been highly celebrated in suppressions of urine, in all kinds of obstructions of the bowels, in the jaundice, weakness of sight, and a variety of other disorders. Whether they have any just title to these virtues is greatly to be doubted: thus much is certain, that their real effects come far short of the character usually given them.

MILLET, in botany. See MILIUM.

MILLING OF CLOTH. See FULLING.

MILLION, in arithmetic, the sum of ten hundred thousand, or a thousand times a thousand. See ARITHMETIC.

MILLO, a part of mount Zion at its extremity; and therefore called *Millo*, of the city of David, (2 Chron. xxxii.) taken in with the wall that encom-

passed mount Zion. Uncertain whether *Beth-Millo*, (Judges ix. 20.) denotes a place; if it did, it lay near Sechem.

MILLO, an island in the Archipelago, about 50 miles in circumference, with a harbour, which is one of the largest and best of the Mediterranean, and which serves for a retreat for all the ships that go to or return from the Mediterranean. The inhabitants are all Greeks, except the *cati*, or judge, who is a Turk. Salt is so cheap, that they sell 67 pounds for sevenpence. There are two bishops, the one of the Greeks, and the other of the Latin church; and there are 13 monasteries in this island. In the spring the whole island is like a carpet thick set with anemones of all sorts and colours. There are public baths at the foot of a small hill going from the town to the harbour; they are in a cavern, with a very narrow entrance of 50 paces long. When a person is got in, the sweat gushes out in large drops; and this sweating is esteemed good for the palsy, rheumatism, and other diseases. Below these baths, near the shore, there are many little springs, so hot as to scald one's fingers. Four miles from the town, in a very steep place by the sea, is a grotto, 15 paces deep, which is all crusted over with plume-alum, in some places as white as snow, and reddish in others. Some paces from this cavern, on the sea-shore, is another grotto, whose bottom is filled with sulphur, which burns continually. Those who are troubled with the itch go and sweat here, and are generally cured. Near the chapel of St Surricus is a spot of ground continually burning; and the fields about it are always smoking, and yet they are all covered with marigolds. Though the air of Milo is very unwholesome, yet the inhabitants lead a merry life, and regale themselves very cheap; but the women are not very famous for chastity. They have partridges, turtle-doves, quails, wheat-ears, wood-pigeons, and ducks, in great plenty; as also good figs, melons, excellent grapes, and very delicate fish. The principal town is of the same name as the island, and contains near 5000 inhabitants. It is prettily built, but abominably nasty; the houses are two stories high, with flat roofs, and are built with a sort of pumice-stone, which is hard, blackish, and yet very light. This island is 60 miles north of Candia, and the town is situated in E. Long. 25. 15. N. Lat. 36. 27.

MILT, in anatomy, a popular name for the spleen.

MILT, or *Melt*, in natural history, the soft roe in fishes; thus called by reason it yields, by expression, a whitish juice resembling milk. See ROE.

The milt is properly the feed or spermatie part of the male fish. The milt of a carp is reckoned a choice bit. It consists of two long whitish irregular bodies, each included in a very thin fine membrane. M. Petit considers them as the testicles of the fish wherein the seed is preserved; the lower part, next the anus, he takes for the *vesiculae seminales*.

MILTIADES, a celebrated Athenian captain, who, with 12,000 men, routed about 300,000 Persians at Marathon, and, pursuing them, took many islands in the Archipelago: but returning to Athens without taking Paros, his fellow-citizens, forgetting the important services he had rendered them, sentenced him to pay a large fine. Being unable to advance the money, he was thrown into prison, where he languished



Milton. ed out the remainder of his days.

MILTON (John), the most illustrious of the English poets, was descended of a genteel family, seated at a place of their own name, viz. *Milton*, in Oxfordshire. He was born December 9. 1608, and received his first rudiments of education under the care of his parents, assisted by a private tutor. He afterwards passed some time at St Paul's school, London; in which city his father had settled, being engaged in the business of a scrivener. At the age of 17, he was sent to Christ's college, Cambridge; where he made a great progress in all parts of academical learning; but his chief delight was in poetry. In 1608, he proceeded bachelor of arts, having performed his exercise for it with great applause. His father designed him for the church; but the young gentleman's attachment to the muses was so strong, that it became impossible to engage him in any other pursuits. In 1632, he took the degree of master of arts; and having now spent as much time in the university as became a person who determined not to engage in any of the three professions, he left the college, greatly regretted by his acquaintance, but highly displeas'd with the usual method of training up youth there for the study of divinity; and being much out of humour with the public administration of ecclesiastical affairs, he grew dissatisfied with the established form of church-government, and disliked the whole plan of education practis'd in the university. His parents, who now dwelt at Horton, near Colnbrook, in Buckinghamshire, received him with unabated affection, notwithstanding he had thwarted their views of providing for him in the church, and they amply indulg'd him in his love of retirement; wherein he enriched his mind with the choicest stores of Grecian and Roman literature; and his poems of *Comus*, *L'Allegro*, *Il Penseroso*, and *Lycidas*, all wrote at this time, would have been sufficient, had he never produced any thing more considerable, to have transmitted his fame to latest posterity. However, he was not so absorbed in his studies as not to make frequent excursions to London; neither did so much excellence pass unnoticed among his neighbours in the country, with the most distinguished of whom he sometimes chose to relax his mind, and improve his acquaintance with the world as well as with books.

After five years spent in this manner, he obtained his father's permission to travel for farther improvement.—At Paris he became acquainted with the celebrated Hugo Grotius; and from thence travelling into Italy, he was every where caressed by persons of the most eminent quality and learning.

Upon his return home, he set up a genteel academy in Aldersgate-street.—In 1641, he began to draw his pen in defence of the Presbyterian party; and the next year he married the daughter of Richard Powell, Esq; of Forest-Hill in Oxfordshire. This lady, however, whether from a difference on account of party, her father being a zealous royalist, or some other cause, soon thought proper to return to her relations; which so incensed her husband, that he resolved never to take her again, and wrote and published several tracts in defence of the doctrine and discipline of divorce. He even made his addresses to another lady; but this incident proved the means of a reconciliation with Mrs Milton.

In 1644, he wrote his Tract upon Education; and the restraint on the liberty of the press being continued by act of parliament, he wrote boldly and nobly against that restraint.

In 1645, he published his juvenile poems; and about two years after, on the death of his father, he took a smaller house in High Holborn, the back of which opened into Lincoln's-Inn Fields.—Here he quietly prosecuted his studies, till the fatal catastrophe and death of Charles I.; on which occasion he published his *Tenure of Kings and Magistrates*, in justification of the fact. He was now taken into the service of the commonwealth, and made Latin secretary to the council of state, who resolved neither to write to others abroad, nor to receive any answers, except in the Latin tongue, which was common to them all. The famous *ERUD. BACRIDIAN* coming out about the same time, our author, by command, wrote and published his *Iconoclastes* the same year. It was also by order of his masters, backed by the reward of 1000*l.* that, in 1651, he published his celebrated piece, entitled *Pro Populo Anglicano Defensio*, “A Defence of the People of England, in answer to Salmastius's Defence of the King;” which performance spread his fame over all Europe.—He now dwelt in a pleasant house, with a garden, in Petty France, Westminster, opening into St James's Park. In 1652, he buried his wife, who died not long after the delivery of her fourth child; and about the same time he also lost his eye-sight, by a *gutta serena*, which had been growing upon him many years.

Cromwell took the reins of government into his own hands in the year 1653; but Milton still held his office. His leisure-hours he employed in prosecuting his studies, wherein he was so far from being discouraged by the loss of his sight, that he even conceived hopes this misfortune would add new vigour to his genius; which, in fact, seems to have been the case.—Thus animated, he again ventured upon matrimony: his second lady was the daughter of Captain Woodcock of Hackney: she died in childbed about a year after.

On the deposition of the protector, Richard Cromwell, and on the return of the long parliament, Milton being still continued secretary, he appeared again in print; pleading for a farther reformation of the laws relating to religion; and, during the anarchy that ensued, he drew up several schemes for re-establishing the commonwealth, exerting all his faculties to prevent the return of Charles II. England's destiny, however, and Charles's good fortune, prevailing, our author chose to consult his safety, and retired to a friend's house in Bartholomew-Close. A particular prosecution was intended against him; but the just esteem to which his admirable genius and extraordinary accomplishments entitled him, had raised him so many friends, even among those of the opposite party, that he was included in the general amnesty.

This storm over, he married a third wife Elizabeth, daughter of Mr Minshall a Cheshire gentleman; and not long after he took a house in the Artillery Walk, leading to Bunhill-Fields.—This was his last stage: here he sat down for a longer continuance than he had been able to do any where; and though he had lost his fortune, (for every thing belonging to him went to  
 wreck

Milton.

Milvius  
—  
Mimner-  
mus.

wreck at the Restoration), he did not lose his taste for literature, but continued his studies with almost as much ardour as ever; and applied himself particularly to the finishing his grand work, the *Paradise Lost*; one of the noblest poems that ever was produced by human genius.—It was published in 1667, and his *Paradise Regained* came out in 1670.—This latter work fell short of the excellence of the former production; although, were it not for the transcendent merit of the *Paradise Lost*, the second composition would doubtless have stood foremost in the rank of English epic poems.—After this he published many pieces in prose; for which we refer our readers to the edition of his Historical, Poetical, and Miscellaneous Works, printed by Millar, in 2 vols 4to. in 1753.

In 1674, this great man paid the last debt to nature, at his house in Bunhill-Fields, in the 66th year of his age; and was interred on the 12th of November, in the chancel of St Giles's, Cripplegate.—A decent monument was erected to his memory, in 1737, in Westminster Abbey, by Mr Benfon, one of the auditors of the impress.—As to his person, it was remarkably handsome; but his constitution was tender, and by no means equal to his incessant application to his studies.—Though greatly reduced in his circumstances, yet he died worth 1500l. in money, beside his household goods.—He had no son; but left behind him three daughters, whom he had by his first wife.

MILVIUS, MOLVIUS, or *Mulvius Pontis*, a bridge on the Tiber, built by *Emilius Scaurus* the censor, in the time of *Sylla*, at two miles distance from the city, on the *Via Flaminia*, and repaired by *Augustus*. From this bridge the ambassadors of the *Allobroges* were brought back to *Rome*, by *Cicero's* management, and made a discovery of *Catiline's* conspiracy (*Sallust*.) Near it *Maxentius* was defeated by *Constantine*, (*Eutropius*.) Now called *Ponte Mollis*.

MILVIUS, in ornithology, a species of *FALCO*.

MIME, in the ancient comedy, a person who acted any character by mere gestures, and hence denominated *pantomime*. See *PANTOMIME*.

MIMESIS, in rhetoric, the imitating the voice and gestures of another person.

MIMNERMUS, an ancient poet and musician, flourished about the beginning of the 6th century B. C. He was of *Smyrna*, and cotemporary with *Solon*. *Athenæus* gives him the invention of pentameter verse. His elegies, of which only a few fragments are preserved, were so much admired in antiquity, that *Horace* preferred them to those of *Callimachus*. He composed a poem of this kind, as we learn from *Pausanias*, upon the battle fought between the people of *Smyrna*, and the *Lydians*, under *Gyges*. He likewise was author of a poem in elegiac verse, quoted by *Strabo*, which he intitled *Nanno*, and in which we may suppose he chiefly celebrated a young and beautiful girl of that name, who, according to *Athenæus*, was a player on the flute, with whom he was enamoured in his old age. With respect to love-matters, according to *Propertius*, his verses were more valuable than all the writings of *Homer*.

*Plus in amore valet Mimnermi versus Homero.*

Lib. i. Eleg. 9. v. 11.

And *Horace* bears testimony to his abilities, in describing that seducing passion:

*Si Mimnermus uti censet, sine amore jocisqve  
Nil est jucundum, vivas in amore jocisqve.*

Epist. VI. Lib. i. v. 65.

If, as wife *Mimnermus* said,  
Life unblest with love and joy,  
Ranks us with the senseless dead,  
Let these gifts each hour employ.

Alluding to some much admired lines of this Greek poet, which were before preferred by *Stobæus*.

*Τις δὲ βίος, τὶ δὲ τέρψων ἀπὶ χυμῶν Ἀρποδῖνος, &c.*

What is life and all its pride,  
If love and pleasure be denied?  
Snatch, snatch me hence, ye fates, whene'er  
The am'rous bliss I cease to share.  
Oh let us crop each fragrant flow'r,  
While youth and vigour give us pow'r;  
For frozen age will soon destroy  
The force to give or take a joy;  
And then, a prey to pain and care,  
Deserted by the young and fair,  
The sun's blest beams will hateful grow,  
And only shine on scenes of woe!

MIMOSA, the SENSITIVE PLANT; a genus of the monocœcia order, belonging to the polygamia class of plants.

This genus comprises shrubby and herbaceous plants, but mostly of the shrub kind, some trailing, others erect, all natives of the *Indies*, &c. retained here in stoves as great curiosities, particularly for the very singular sensibility of the leaves of some sorts, which on being touched, suddenly recede, contract, and fall down in a very wonderful manner: all of them garnished with pinnated leaves, and monopetalous, funnel-shaped, five-parted, polygamous flowers at the axillas and ends of the branches in clusters and spikes.

The name *mimosa* of this genus, signifies mimic, originating from the sensibility of the leaves, which, by their motion, mimic or imitate, as it were, the motions of animals.

To this genus *Linnaeus* joins many of the *acacias*, and it comprises upwards of 40 different species; tho' not more than a quarter of them are common in the *English* gardens, or possess any particular merit either for curiosity or ornament, and none for use. Of the sorts cultivated here in our stoves, &c. some are of the shrub and tree kind, and two or three are herbaceous perennials and annuals; are mostly of the sensitive kinds, except the *acacia* sorts, which are motionless, as expressed under their proper heads, i. e. sensitive and humble kinds, and senseless kinds. The former of which are exceedingly curious plants in the very singular circumstance of their leaves receding rapidly from the touch; the leaves are winged, each composed of numerous small lobes, all of which on being touched, hastily run up close together; and in some sorts the footstalks and all are affected, so as instantly to fall downward, as if fastened by hinges.

*Shrubby, Sensitive, and Humble Kinds.*

They have all winged leaves, each wing consisting of many small pinnæ; some only contract the lobes of the leaves and pinnæ at the touch; others not only contract every part of their leaves, but their footstalks also suddenly drop downward; and for distinction sake, the former are called *sensitive mimosæ*, and the latter *humble sensitives*; but the leaves of both sorts soon recover their usual position. The most remarkable species are,

Mimosa.

Mimosa.

Mimosa.

1. *Sensitiva*, or common sensitive humble plant. Rises with an undershrubby prickly stem, branching six or eight feet high, armed with crooked spines; conjugated, pinnated leaves, with bigugated partial lobes, or wings, having the inner ones the least, each leaf on a long footstalk; and at the sides and ends of the branches many purple flowers in roundish heads; succeeded by broad, flat, jointed pods, in radiated clusters.

This is somewhat of the humble sensitive kind; the leaves, footstalks and all, recede from the touch, though not with such facility as in some of the following sorts.

2. The *podica*, or bathful humble plant. Rises with an undershrubby, declinated, prickly stem, branching two or three feet around, armed with hairy spines; pinnated, digitated leaves, each leaf being of five or more long folioles, attached by their base to a long footstalk, and spread out above like the fingers of a hand; and at the sides and ends of the branches roundish heads of greenish white flowers, succeeded by small, jointed, prickly pods.

This is truly of the humble sensitive kind; for by the least touch the leaves instantly recede, contract close, and, together with the footstalk, quickly decline downward, as if ashamed at the approach of the hand.

3. The *pernambucana*, or pernambuca slothful mimosa. Hath undershrubby, procumbent, unarmed stems, branching two or three feet around; bipinnated leaves, of three or four pair of short, winged foliola; and at the axillas drooping spikes of pentandrous flowers, the lower ones castrated.

This sort recedes very slowly from the touch, only contracting its pinnae a little when smartly touched; hence the name *slothful mimosa*.

4. The *asperata*, or rough sensitive mimosa, hath a shrubby, upright, prickly, hairy, rough stem, branching four or five feet high, armed with short, broad, whitish spines; bipinnated, prickly leaves, of five or six pair of foliola, or wings, arranged opposite, having two thorns between each pair; and at the upper axillas globular heads of purple flowers, succeeded by short, flat, jointed pods, in clusters, spreading each way like a radius.

This is only moderately sensitive in its foliola, but not in the footstalks.

5. The *punctata*, or punctated sensitive mimosa, rises with a shrubby, upright, taper, punctated, or spotted, unarmed stem, branching erectly five or six feet high; bipinnated leaves, of four or five pair of long, winged folioles, having each about 20 pair of pinnae; and at the axillas and termination of the branches oblong spikes of yellowish decandrous flowers, the inferior ones castrated; succeeded above by oblong seed-pods. This sort, though naturally shrubby and perennial in its native soil, yet in this country it sometimes decays in winter. It is only sensitive in the foliola, but quick in the motion.

#### *Herbaceous Sensitive and Humble Kinds.*

Of these sorts two are perennial of the trailing kind; and one is annual, of somewhat erect growth; have all winged leaves, with the wings formed of many small pinnae.

6. The *viva*,—perennial, or lively sensitive mimosa,

hath herbaceous, trailing, unarmed, repent stems, very brachy, spreading widely around, rooting at the joints as they advance; conjugated pinnated leaves, with quadrjugated, roundish, partial lobes, or wings; and at the axillas globular heads of yellowish flowers; succeeded by short, flat, jointed pods.

This species is only sensitive in the foliola; but is the most lively of that kind, it being so susceptible that all the foliola recede rapidly from the least touch, whereby it has the distinctive appellation of *vivacious*, or *lively mimosa*.

7. The *quadrivalvis*;—perennial, or quadrivalve humble mimosa, hath herbaceous slender, quadrangular, prickly stems, branching and spreading all around, armed with recurved spines; bipinnated leaves of two or three pair of winged lobes, having each many pinnae; and at the axillas globular heads of purple flowers, succeeded by quadrangular pods.

This is of the humble sensitive kind, both leaves and footstalks recede from the touch.

8. The *plena*,—annual, or double-flowered sensitive annual mimosa, rises with an herbaceous, erect, round, unarmed stem, closely branching and spreading every way, three or four feet high; bipinnated leaves of four or five pair of winged lobes, of many pairs of pinnae; and at the axillas and termination of the branches spikes of yellow pentandrous flowers, the lower ones double; succeeded by short broad pods.

This annual is only sensitive in the foliola, but extremely sensible of the touch or air.

#### *Shrubby Insensible Kinds.*

These are of the *acacia* kind, formerly a distinct genus, but now all species of *Mimosa*; but their leaves are destitute of motion or sensibility at the touch: there are about three noted species in the English gardens, all for the love.

9. The *cornigera*, or horned Mexican mimosa, commonly called *great horned acacia*, hath a shrubby, upright, deformed stem, branching irregularly, armed with very large, horned-like white spines, by pairs, connated at the base; bipinnated leaves thinly placed; and flowers growing in spikes.

This species is esteemed a curiosity for the oddity of its large spines, resembling the horns of animals, and which are often variously wreathed, twisted, and contorted.

10. The *farnesiana*, or farnesian fragrant acacia, hath a shrubby stem, branching many feet high, armed with distinct spines; bipinnated leaves, having eight pair of partial lobes, or wings; and globular, close-sitting spikes of yellow sweet-scented flowers.

11. The *nilotica*, or nilotic true Egyptian acacia, hath an upright tree-stem, branching many feet high, armed with spreading spines; bipinnated leaves; and globular spikes of flowers, having footstalks. From the exudation of the leaves of this sort is procured the drugs called *succus acaciae* and *gum-arabic*.

*Propagation, &c.* These 11 species of mimosa are the most noted sorts in the English gardens; and all the shrubby kinds are durable in root, stem, and branches; those of the perennial herbaceous kinds are also often abiding; but the annual sort always perish, root and branch, at the approach of winter. They are all natives of the Indies; and in this country require the continual shelter of a hot-house, or of a hot-bed of similar

Mindanao.

lar temperature under frames and glasses; though they can hardly be supported alive in winter unless placed in a stove; so all the forts must constantly be kept in pots, and placed principally in that department, especially during the winter; nor will they succeed well in the open air in summer, except about a month during the greatest heat; but the sensitive and humble kinds, if exposed to the open air, even in the hottest days, will be deprived of their sensibility during the time they remain so exposed, therefore should always be kept under glasses, in a stove if possible; or in default of such a convenience, the plants might be raised from seed in spring in any common hot-bed under frames, &c. as directed for tender annuals, and continued constantly under the glasses, and thereby will afford pleasure all summer by the oddity of their sensitive foliage; however, to have them to remain in perfection the year round, some must be continued always in a stove, as before observed; for the warmer they are kept, the stronger will be their sensible quality: but for a particular account of this quality, see the article SENSITIVE Plant.

The propagation of all the forts, both sensitive and acacias, is by seed in spring in a hot-bed, or in the bark-bed in the stove; and some of the sensitive kinds also by layers and cuttings.

MINA, in Grecian antiquity, a money of account, equal to 100 drachms.

MIND, a thinking intelligent being, otherwise called *spirit*, in opposition to matter, or body.

MINDANAO, a large island of Asia in the East Indies, and one of the Philippines; 180 miles in length, and 120 in breadth. It is a very mountainous country, full of hills and valleys, and the mould is generally deep, black, and fruitful. The sides of the hills and valleys are stony, and yet there are tall trees of kinds not known in Europe: some of the mountains yield very good gold, and the valleys are watered with variety of rivulets. The palm-trees † produce the sago, which the poor people eat, instead of bread, three or four months in the year. They have here all sorts of fruits, proper to the climate, besides plenty of rice: some affirm that there are nutmegs and cloves, but none of the trees that bear them appear near the coast. They have horses, bees, buffaloes, goats, deer, monkeys, lizards, and snakes; but they have neither lions nor tygers. Their hogs are very ugly creatures, having all great knobs growing over their eyes; however, their flesh is sweet. Their fowls are ducks, hens, pigeons, parrots, paroquets, turtle-doves, and bats as large as kites, besides many small birds. The air is temperate, they having breezes by day, and cooling land-winds at night. The winds are easterly one part of the year, and westerly the other: while the former blow, it is fair weather; but while the latter, it is rainy, stormy, and tempestuous. The inhabitants are of a mean low stature, with small limbs and little heads. Their faces are oval, with flat foreheads, black small eyes, short low noses, and pretty large mouths. Their hair is black and straight, and their complexion tawney, but more inclining to yellow than that of other Indians. The women are very desirous of the company of strangers, especially white men. The chief trades are goldsmiths, blacksmiths, and carpenters; and they can build pretty good vessels for the sea.

Their distempers are as in other places, except the le-  
Mindelheim Mine.

MINDELHEIM, a town of Germany, in the circle of Suabia, and in Algow, with a castle. It is capital of a small territory between the rivers Iller and Lech, subject to the house of Bavaria. It was taken by the Imperialists after the battle of Hochstet, who erected it into a principality in favour of the duke of Marlborough; but it returned back to the house of Bavaria by the treaty of Rastat. It is 33 miles south-east of Ulm. E. Long. 10. 40. N. Lat. 48. 5.

MINDELHEIM, a district of Germany, in Suabia, lying between the bishopric of Augsburg and the abbacy of Kempten, which is 20 miles in length and 16 in breadth.

MINDEN, a considerable town of Germany, in the circle of Westphalia, and capital of a territory of the same name; seated on the river Weser, which renders it a trading-place. It belongs to the king of Prussia, who has secularized the bishopric. It is 27 miles east-by-south of Osnaburg, and 37 west of Hanover. E. Long. 9. 5. N. Lat. 52. 22.

MINDEN (the principality of), in Germany, lies in the circle of Westphalia; to the north of the county of Ravenberg, and along each side of the river Weser. It is about 22 miles square, and Minden and Petershagen are the principal places. It was formerly a bishopric, but is now secularized; and was ceded to the elector of Brandenburg by the treaty of Westphalia.

MINDORA, an island of Asia, in the East Indies, and one of the Philippines, 50 miles in circumference, and separated from Luconia by a narrow channel. It is full of mountains, which abound in palm-trees and all sorts of fruits. The inhabitants are idolaters, and pay tribute to the Spaniards, to whom this island belongs.

MINE, in natural history, a place under ground, where metals, minerals, or even precious stones, are dug up.

As, therefore, the matter dug out of mines is various, the mines themselves acquire various denominations, as *gold mines, silver mines, copper mines, iron mines, diamond mines, salt mines, mines of antimony, of alum, &c.*

Mines, then, in general, are veins or cavities within the earth, whose sides receding from, or approaching nearer to each other, make them of unequal breadths in different places, sometimes forming larger spaces, which are called *heles*: they are filled with substances, which, whether metallic or of any other nature, are called the *loads*; when the substances forming these loads are reducible to metal, the loads are by the miners said to be alive, otherwise they are called *dead loads*. In Cornwall and Devon, the loads always  
hold

† See Palma.

Mine.

hold their course from eastward to westward; though in other parts of England they frequently run from north to south. The miners report, that the sides of the load never bear in a perpendicular, but constantly under-ly either to the north or to the south. The load is frequently intercepted by the crossing of a vein of earth or stone, or some different metallic substance; in which case it generally happens that one part of the load is moved a considerable distance to the one side. This transient load is by the miners called *flooting*; and the part of the lead which is to be moved is said to be heaved.

According to Dr Nicols's observations upon mines, they seem to be, or to have been, the channels thro' which the waters pass within the earth, and, like rivers, have their small branches opening into them in all directions. Most mines have streams of water running through them: and when they are found dry, it seems to be owing to the waters having changed their course, as being obliged to it, either because the load has stopped up the ancient passages, or that some new and more easy ones are made.

Mines, says Dr Shaw, are liable to many contingencies; being sometimes poor, sometimes soon exhausted, sometimes subject to be drowned, especially when deep, and sometimes hard to trace. Yet there are many instances of mines proving highly advantageous for hundreds of years: the mines of Potosi are to this day worked with nearly the same success as at first; the gold mines of Cremnitz have been worked almost these 1000 years; and our Cornish tin mines are extremely ancient. The neat profit of the silver alone, dug in the Misnian silver-mines in Saxony, is still, in the space of eight years, computed at a thousand six hundred and forty-four millions, besides seventy-three tons of gold. Many mines have been discovered by accident: a torrent first laid open a rich vein of the silver-mine at Friburg in Germany; sometimes a violent wind, by blowing up trees, or overturning the parts of rocks, has discovered a mine; the same has happened by violent showers, earthquakes, thunder, the firing of woods, or even the stroke of a ploughshare or horse's hoof.

But the art of mining does not wait for these favourable accidents, but directly goes upon the search and discovery of such mineral veins, ores, or sands, as may be worth the working for metal. The principal investigation and discovery of mines depend upon a particular sagacity, or acquired habit of judging from particular signs, that metallic matters are contained in certain parts of the earth, not far below its surface. The principal signs of a latent metallic vein seem reducible to general heads; such as, 1. The discovery of certain mineral waters. 2. The discolouration of the trees or grafs of a place. 3. The finding of pieces of ore on the surface of the ground. 4. The rise of warm exhalations. 5. The finding of metallic sands, and the like. All which are so many encouragements for making a stricter search near the places where any thing of this kind appears; whence rules of practice might be formed for reducing this art to a greater certainty. But when no evident marks of a mine appears, the skilful mineralist usually bores into the earth, in such places as, from some analogy of knowledge, gained by experience, or by observing the situation,

course, or nature of other mines, he judges may contain metal. As to the power of the divining wand in discovering mines, it seems to be a mere chimera. See *Divining WAND*.

After the mine is found, the next thing to be considered, is whether it may be dug to advantage. In order to determine this, we are duly to weigh the nature of the place, and its situation, as to wood, water, carriage, healthiness, and the like; and compare the result with the richness of the ore, the charge of digging, stamping, washing, and smelting.

Particularly the form and situation of the spot should be well considered. A mine must either happen, 1. In a mountain. 2. In a hill. 3. In a valley. Or, 4. In a flat. But mountains and hills are dug with much greater ease and convenience, chiefly because the drains and burrows, that is, the adits or avenues, may be here readily cut, both to drain the water and to form gang-ways for bringing out the lead, &c. In all the four cases, we are to look out for the veins which the rains, or other accidental thing, may have laid bare; and if such a vein be found, it may often be proper to open the mine at that place, especially if the vein prove tolerably large and rich: otherwise the most commodious place for situation is to be chose for the purpose, *viz.* neither on a flat, nor on the tops of mountains, but on the sides. The best situation for a mine, is a mountainous, woody, wholesome spot; of a safe easy ascent, and bordering on a navigable river. The places abounding with mines are generally healthy, as standing high, and every where exposed to the air; yet some places, where mines are found, prove poisonous, and can upon no account be dug, tho' ever so rich: the way of examining a suspected place of this kind, is to make experiments upon brates, by exposing them to the effluvia or exhalations, to find the effects.

Devonshire and Cornwall, where there are a great many mines of copper and tin, is a very mountainous country, which gives an opportunity in many places to make adits, or subterraneous drains, to some valley at a distance, by which to carry off the water from the mine, which otherwise would drown them out from getting the ore. These adits are sometimes carried a mile or two, and dug at a vast expence, as from 2000 l. to 4000 l. especially where the ground is rocky; and yet they find this cheaper than to draw up the water out of the mine quite to the top, when the water runs in plenty, and the mine is deep. Sometimes, indeed, they cannot find a level near enough to which an adit may be carried from the very bottom of the mine; yet they find it worth while to make an adit at half the height to which the water is to be raised, thereby saving half the expence.

The late Mr Costar, considering that sometimes from small streams, and sometimes from little springs or collections of rain-water, one might have a good deal of water above ground, though not a sufficient quantity to turn an overshot-wheel, thought, that if a sufficient fall might be had, this collection of water might be made useful in raising the water in a mine to the adit, where it may be carried off.

But now the most general method of draining mines is by the fire or steam engine. See *STEAM-ENGINE*.

Mine.

Mineral.

MINE, in the military art, denotes a subterranean canal or passage, dug under the wall or rampart of a fortification, intended to be blown up by gun-powder.

The alley or passage of a mine is commonly about four feet square; at the end of this is the chamber of the mine, which is a cavity about five feet in width and in length, and about six feet in height; and here the gun-powder is stowed. The faucet of the mine is the train, for which there is always a little aperture left. There are various kinds of mines, which acquire various names, as *royal mines*, *serpentine mines*, *forked mines*, according as their passages are straight, oblique, winding, &c.

MINERAL, in natural history, is used in general for all fossil bodies, whether simple or compound, dug out of a mine; from whence it takes its denomination.

MINERAL Waters. All waters naturally impregnated with any heterogeneous matter which they have dissolved within the earth may be called *mineral waters*, in the most general and extensive meaning of that name; in which are therefore comprehended almost all those that flow within or upon the surface of the earth, for almost all these contain some earth or felicitous. But waters containing only earth or felicitous are not generally called *mineral*, but *hard* or *crude waters*.

Hard waters, which are simply felicitous, when tried by the chemical proofs, shew no marks of an acid or of an alkali, nor of any volatile, sulphureous, or metallic matters. Waters which contain a disengaged calcareous earth, change the colour of syrup of violets to a green; and those that contain felicitous, being mixed with a solution of mercury in nitrous acid, form a turbid mineral; and when a fixed alkali is added, they are rendered turbid, and a white sediment is precipitated. These waters also do not dissolve soap well. From these we may know, that any water which produces these effects is a hard, earthy, or felicitous water. The waters impregnated with gas are also hard.

Although the waters of the sea and saline springs be not generally enumerated amongst mineral waters, they might nevertheless be justly considered as such: for besides earthy and felicitous matters, they also contain a large quantity of mineral salts. We shall therefore consider them as such in this article.

Mineral waters, properly so called, are those in which gas, or sulphureous, saline, or metallic substances, are discovered by chemical trials. As many of these waters are employed successfully in medicine, they are also called *medicinal waters*.

Mineral waters receive their peculiar principles by passing through earths containing salts, or pyritous substances that are in a state of decomposition. Some of these waters are valuable from the quantity of useful salts which they contain, particularly of common salt, great quantities of which are obtained from these waters; and others are chiefly valued for their medicinal qualities. The former kind of mineral waters is an object of manufacture, and from them is chiefly extracted that salt only which is most valuable in commerce. See *SALT*.

Many of these waters have been accurately analysed by able chemists and physicians. But notwithstanding these attempts, we are far from having all the

certainty and knowledge that might be desired on this important subject; for this kind of analysis is perhaps the most difficult of any in chemistry.—Almost all mineral waters contain several different substances, which being united with water may form with each other numberless compounds. Frequently some of the principles of mineral waters are in so small quantity, that they can scarcely be perceived; altho' they may have some influence on the virtues of the water, and also on the other principles contained in the water. The chemical operations used in the analysis of mineral waters, may sometimes occasion essential changes in the substances that are to be discovered. And also, these waters are capable of suffering very considerable changes by motion, by rest, and by exposure to air.

Probably also the variations of the atmosphere, subterranean changes, some secret junction of a new spring of mineral or of pure water, lastly the exhaustion of the minerals whence waters receive their peculiar principles, are causes which may occasionally change the quality of mineral waters.

We need not therefore wonder that the results of analyses of the same mineral waters made by different chemists, whose skill and accuracy are not questioned, should be very different.

The consequences of what we have said on this subject are, That the examination of mineral waters is a very difficult task; that it ought not to be attempted but by profound and experienced chemists; that it requires frequent repetitions, and at different times; and lastly, that no fixed general rules can be given concerning these analyses.

As this matter cannot be thoroughly explained without entering into details connected with all the parts of chemistry, we shall here mention only the principal results, and the most essential rules, that have been indicated by the attempts hitherto made on this subject.

We may admit the division or arrangement of mineral waters into certain classes, proposed by some of the best chemists and naturalists.

Some of these waters are called *cold*, because they are not naturally hotter than the atmosphere. Some of them are even colder, especially in summer.

Those are called *hot mineral waters*, which in all seasons are hotter than the air. These are of various degrees of heat, and some of them are almost as hot as boiling water. In some mineral waters certain volatile, spirituous, and elastic principles may be perceived, by a very sensible piquant taste: this principle is called the *gas* or the *spirit of waters*.

The waters which contain this principle are generally lighter than pure water. They sparkle and emit bubbles, at their spring, but especially when they are shook, and poured from one vessel into another. They sometimes break the bottles containing them, when these are well corked, as fermenting wines sometimes do. When mixed with ordinary wine, they give to it the piquancy and sparkling quality of Champagne wine.

This volatile principle, and all the properties of the water dependent upon it, are lost merely by exposure to air, or by agitation. The waters containing this principle are distinguished by the name of *spirituous mineral waters*, or *acidulous waters*.

Mineral.

Other

Mineral.

Mineral.

Other divisions of mineral waters may be made relatively to some of their predominant principles. Hence some waters are called *acidulous, alkaline, martial, neutral, &c.*

When a mineral water is to be examined, we may observe the following rules:

Experiments ought to be made near the spring, if possible.

The situation of the spring, the nature of the soil, and the neighbouring rising grounds, ought to be examined.

Its sensible qualities, as its smell, taste, colour, are to be observed.

Its specific gravity and heat are to be ascertained by the hydrometrical balance and the thermometer.

From the properties above-mentioned of spirituous mineral waters, we may discover whether it be one of this class. For greater certainty we may make the following trial. Let the neck of a wet bladder be tied to the neck of a bottle containing some of this water. By shaking the water, any gas that it may contain will be disengaged, and will swell the bladder. If the neck of the bladder be then tied with a string above the bottle, and be cut below this string, so as to separate the bladder from the bottle, the quantity and nature of the contained gas may be further examined.

Lastly, we must observe the changes that are spontaneously produced upon the water in close and in open vessels, and with different degrees of heat. If by these means any matter be crystallized or deposited, it must be set apart for further examination.

These preliminary experiments and observations will almost certainly indicate, more or less sensibly, something concerning the nature of the water, and will point out the method to be followed in our further inquiry.

We must then proceed to the decomposition of the water, either without addition, and merely by evaporation and distillation, or with the addition of other substances, by means of which the matters contained in the water may be precipitated and discovered. It is not material which of these two methods be first practiced, but it is quite necessary that the one should succeed the other. If we begin by evaporating and distilling, these operations must be sometimes interrupted, that the several principles which rise at different times of the distillation may be obtained and examined separately, and also to allow the several salts that may be contained to crystallize by the evaporation and by cold.

The substances generally found in mineral waters, are almost always combinations of vitriolic acid, and those of marine acid, together with the several matters that these acids are capable of dissolving.

The following combinations of vitriolic acid are found in mineral waters.

1. *Volatile sulphureous acid.* This is seldom found, both because it easily loses its phlogiston, and because it must almost always meet with some substance that it is capable of dissolving.

2. *Sulphur.* This is found sometimes singly, but generally in form of a liver of sulphur. In these waters, sulphur is formed into a hepar by means of calcareous earth or of mineral alkali.

3. *Vitriolic salts with earthy bases.* These salts are

frequently *selenitic*, that is, their acid is combined with a calcareous earth; or they are of the nature of Epsom salt, the basis of which is magnesia. Sometimes, but not so frequently, they are *aluminous*, when their acid happens to be united with an argillaceous earth.

4. *Vitriols.* *Martial vitriol* is frequently contained in mineral waters; *vitriol of copper* is sometimes, but seldom, and *vitriol of zinc* is still more rarely found in these waters. The vitriols of other metallic substances are scarcely ever, but in very singular cases, found in water.

5. Lastly, *vitriolic salts with basis of fixed alkali.* This is always *Glauber's salt*. Neither *vitriolated tartar* nor *vitriolic ammoniacal salt* are ever found, unless by some singular accident, in mineral waters.

The combinations of marine acid that are contained in mineral waters are *common salt*, and *marine salt with earthy basis*. For no combinations of this acid with phlogiston are known, and it is very seldom found united with any metallic substance.

Compounds formed of the nitrous acid with an earthy basis are very common in waters in this country, inasmuch that some have thought that nitre might be extracted from them advantageously in the way of trade. See CHEMISTRY, n° 178. In France, however, the case seems to be otherwise; for Mr Macquer determines, in his Chemical Dictionary, that the nitrous acid is not (nay that it *cannot*) be found in waters except by accident.

These are the principal substances that form almost all these waters. We shall now shew the proofs by means of which they may be discovered in water, without decomposing the water by evaporation or by distillation.

If any portion of disengaged acid or alkali be contained in water, it may be known by the taste, by changing the colour of violets or of turnsol, and by adding the precise quantity of acid or of alkali that is necessary for the saturation of the contained disengaged saline matter.

Sulphur, and liver of sulphur, may be discovered in waters by their singular smell, and by the black colour which these substances give to white metals or to their precipitates, but especially to silver.

Vitriolic salts with earthy basis may be discovered in water by two proofs: 1. By adding some fixed alkali, which decomposes all these salts, and precipitates their earthy basis; and, 2. By adding a solution of mercury in nitrous acid, which also decomposes these salts, and forms a *turbith mineral* with their acid. But for this purpose the solution of mercury ought to have a superabundant quantity of acid: for this solution, when perfectly saturated, forms a precipitate with any kind of water, as M. Rouelle has very justly remarked; and indeed, all metallic solutions in any acids are strictly capable of decomposition by water alone, and so much more easily as the acid is more perfectly saturated with the metal.

Martial vitriol or iron combined with any acid, or even with gas, shews itself in waters by blackening an infusion of galls, or by forming a Prussian blue with the phlogisticated alkaline lixivium.

The vitriol of copper, or copper dissolved by any acid, may be discovered by adding some of the vola-

Mineral.

tile spirit of fal ammoniac, which produces a fine blue colour; or by the addition of clean iron, upon the surface of which the copper is precipitated in its natural or metallic state.

Glauber's salt is discovered by adding a solution of mercury in nitrous acid, and forming with it a turbith mineral; or by crystallization.

Common salt contained in waters forms with a solution of silver in nitrous acid a white precipitate, or luna cornea. It may also be known by its crystallization. Marine salt with earthy basis produces the same effect upon solution of silver. It also forms a precipitate when fixed alkali is added. The acrimony, bitterness, and deliquescency of this salt, serve to distinguish it.

The proofs related for the examination of mineral waters, are only those which are most essential. Many others may be made to confirm the former proofs: but the details of these are too extensive to be inserted here. We shall add only two of these, because they are very general, and may be very useful.

The first is the production of artificial sulphur, or of the volatile sulphureous acid; by which means the vitriolic acid may be discovered in any combination whatever. For this purpose, the matter to be examined must be mixed with any inflammable substance, and exposed to a red heat. If this matter contained but a particle of vitriolic acid, it would be rendered sensible by the sulphur, or by the volatile sulphureous acid thence produced.

The second general proof for mineral waters which we shall mention here, serves to discover any metallic substance whatever, dissolved in water by any acid. This proof consists in adding some of the liquor satu-

rated by the colouring matter of Prussian blue, described under the article CHEMISTRY, n<sup>o</sup> 391. This liquor produces no effects upon any neutral salts with earthy or alkaline bases, but decomposes all metallic salts: so that if no precipitate be formed upon adding some of this liquor, we may be certain that the water does not contain any metallic salt; and on the contrary, if a precipitate be formed, we may certainly infer that the water does contain some metallic salt.

Two kinds only of gas, or the spirituous volatile part of some waters, are hitherto known; of which one is the volatile sulphureous acid, and the other is fixed air, See AIR, FIXED AIR, and GAS, *passim*. Air united superabundantly with spirituous waters is the chief cause of their lightness, piquancy, and sparkling.

When the nature and quantities of the principles contained in a mineral water are ascertained by suitable experiments, we may imitate artificially this water, by adding to pure water the same proportions of the same substances, as Mr Venel has done in examining several waters, especially that of Selters.

We may easily perceive the necessity of using no vessels in these experiments, but such as are perfectly clean and rinsed with distilled water; of weighing the products of the experiments very exactly; of making the experiments upon as large quantities of water as is possible, especially the evaporations, crystallizations, and distillations; and of repeating all experiments several times. We may further observe, that the mixtures from which any precipitates might be expected ought to be kept two or three days, because many of these precipitates require that time, or more, to appear, or to be entirely deposited.

## M I N E R A L O G Y,

1 IS that science which teaches us the properties of mineral bodies, and by which we learn how to characterize, distinguish, and class them into a proper order.

2 Mineralogy seems to have been in a manner coeval with the world. Precious stones of various kinds appear to have been well known among the Jews and Egyptians in the time of Moses; and even the most rude and barbarous nations appear to have had some knowledge of the ores of different metals. As the science is nearly allied to chemistry, it is probable that the improvements both in chemistry and mineralogy have nearly kept pace with each other; and indeed it is but of late, since the principles of chemistry were well understood, that mineralogy hath been advanced to any degree of perfection. The best way of studying mineralogy, therefore, is by applying chemistry to it; and not contenting ourselves merely with inspecting the outsidés of bodies, but decomposing them according to the rules of chemistry. This method hath been brought to the greatest perfection by Mr Pott of Berlin, and after him by Mr Cronstedt of Sweden. To obtain this end, chemical experiments in the large way are without doubt necessary; but as a great deal of the mineral kingdom has already been examined in this manner, we do not need to repeat all those experiments in their whole extent, unless

some new and particular phenomena should discover themselves in those things we are examining; else the tediousness of those processes might discourage some from going farther, and take up much of the time of others that might be better employed. An easier way may therefore be adopted, which even for the most part is sufficient, and which though made in miniature, yet is as scientific as the common manner of proceeding in the laboratories, since it imitates that, and is founded upon the same principles. This consists in making the experiments upon a piece of charcoal with the concentrated flame of a candle blown through a blow-pipe. The heat occasioned by this is very intense; and the mineral bodies may here be burnt, calcined, melted, and scorified, &c. as well as in any great works.

A pocket-laboratory containing all things necessary for trying mineralogical experiments is represented, Plate CLXXXI. fig. 1. with the case, exactly of the form, bigness, and proportions as that made use of by Mr Cronstedt: what alterations there may be wanted are easily found out by practice.

*e, h.* Are the two parts of which the Blow-Pipe consists, and which are already described under that article.

*a.* A wax-candle, destined to be made use of, particularly in travelling, when no other candle is to be had.

Mineral.



Fig. 1.

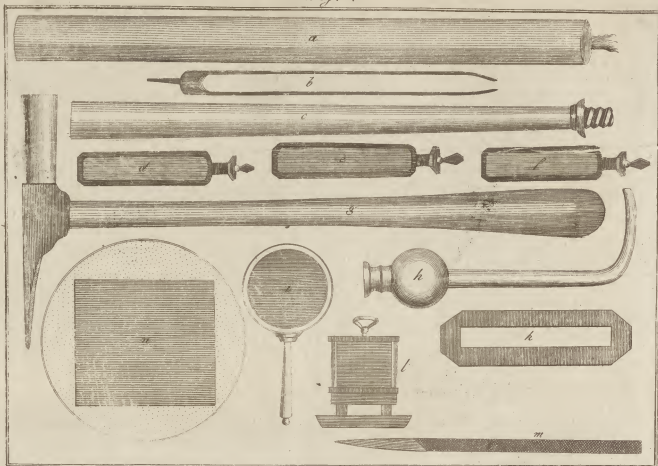


Fig. 2.

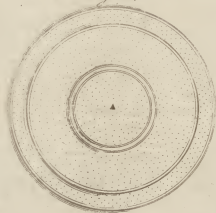


Fig. 3.



Fig. 4.

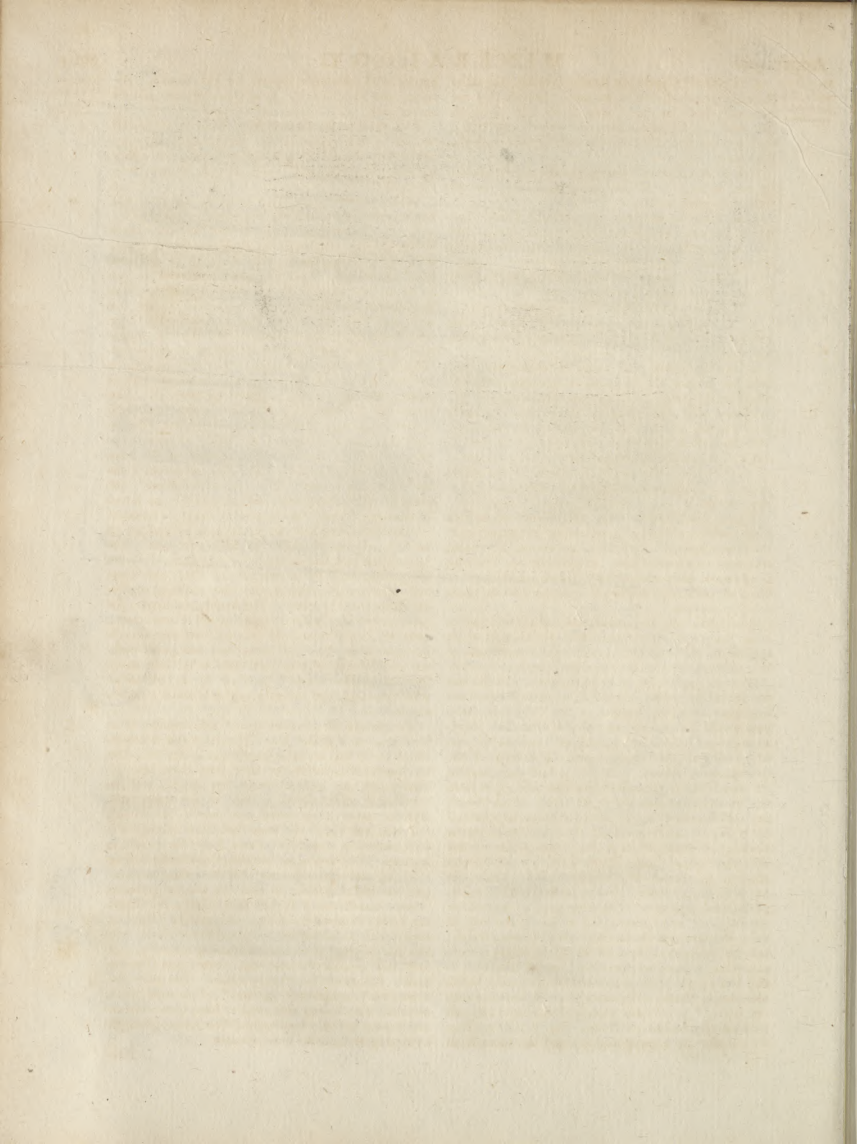


Fig. 5. Trough.



Fig. 6. Matrass.





Method of  
making Ex-  
periments.

Method of  
making Ex-  
periments.

*b.* A pair of nippers, to handle so much the easier these things which are to be tried, because they are generally small particles: this serves also to touch and turn the subjects during the experiments, when they are hot and could not be well handled with the fingers.

*d, e, f.* Are three phials, to put the required fluxes in, viz. borax, the mineral alkali *sal sodæ*, and fal fusibile microcosmicum.

*g.* A hammer, to break any part of a stone, when it is to be tried: this serves also to pound things with.

*i.* A magnifying-glass, necessary when the objects are too small to be seen by the naked eye.

*k.* A steel to strike fire, by which the hardness or softness of the bodies is tried.

*l.* A loadstone, to discover the presence of iron.

*m.* A file, wherewith to distinguish natural gems, quartz-crystals, and artificial or coloured glasses, from one another.

*n.* A thin square plate made of untempered steel, filed flat on one side, to pound things upon, and polished on the other side to hammer metals upon.

Above this steel plate *n*, and within the circle drawn round about it, is the place for a candlestick. This candlestick is shewn in plan, fig. 2. and in profile, fig. 3. It consists of a round brass plate; the point *a*, and the ring *b* round it, is instead of the socket in another candlestick, which would here take up too much room.

Fig. 4. is a thin iron ring, a sixth part of an inch high; within this ring the pounding and grinding of the things upon the steel plate, fig. 1. *n*, is performed, that they may not be lost. In packing up, this ring is to be put loose upon the candlestick; and, as it is lower than the point of this, it does not take up much room in the case.

The whole case thus made, with all the instruments in it, is no more than one and an eighth part of an inch high, and consequently not more troublesome to be carried in the pocket than a small book.

The pocket-laboratory here described, and the box for the acids, to be afterwards mentioned have been improved after the manner of Mr Cronstedt, by a gentleman particularly acquainted with Mr Engestrom, from whom he learned this method of making mineralogical experiments. The bulk of the first has been reduced nine and a half cubic inches; its length being diminished one sixteenth of an inch, the breadth five and the depth two; notwithstanding which, there is also added a piece of charcoal for trying the experiments, a flint, a piece of agaric tinder, and some matches for lighting the candle. The three phials *n m v* for the salts, are of different colours, to prevent any mistake. The candlestick has different concentric grooves for keeping the results of the trials separate. The blow-pipe *s* has a silver mouth-piece, and screws in the middle of the ball, in order to clean out the moisture with the greater ease; and the small wire (Plate CLV. fig. 2. n<sup>o</sup> 1.) is more conveniently detached than fixed round it. The other box for the acids is reduced to less than a fourth of its original bulk, being exactly of the same size with the above. It contains two small matrasses (fig. 4.) for making solutions; a trough (fig. 5.) for washing the ore after its being pounded; and the three small

bottles with double stoppers, for the nitrous, muriatic, and vitriolic acids, have their respective initials cut on each.

Both these pocket-laboratories, made in the neatest manner by an ingenious artist, may be had ready furnished with the purest acids, &c. at the General Office of Business, Arts, and Trade, N<sup>o</sup> 98. Wood-street, Cheap-side.

Whenever any thing is to be tried, one must not begin immediately with the blow-pipe; some preliminary experiments ought to go before, by which those in the fire may afterwards be directed. For instance, a stone is not always homogeneous, or of the same kind throughout, although it may appear to the eye to be so: the magnifying-glass is therefore necessary, to discover the heterogeneous particles, if there be any; and these ought to be separated, and every thing tried by itself, that the effects of two different things, tried together, may not be attributed to one alone. This might happen with some of the finer mica, which are now and then found mixed with small particles of quartz, scarcely to be perceived by the eye. The trapp (in German *schwarzstein*) is also sometimes mixed with very fine particles of felspar (*spatum fentillanum*), or of calcareous spar, &c. After this experiment follows that to try the hardness of the stone in question with the steel. The flint and garnet kinds are commonly known to strike fire with the steel; but there are also other stones, though very seldom, found so hard as to strike fire: a kind of trapp is found of that hardness in which no particles of felspar are to be seen. Coloured glasses resemble true gems; but as they are very soft in comparison to these, they are easily discovered by means of the file: the common quartz-crystals are harder than coloured glasses, but softer than the gems. The loadstone discovers the presence of iron, when it is not mixed in too small a quantity in the stone, and often before the stone is roasted. Some kinds of hematites, and particularly the *cæroleusens*, is very like some other iron ores; but distinguishes itself from these by a red colour when pounded, and others giving a blackish powder, and so forth.

To manage the blow-pipe with ease requires some practice. A beginner blows generally too strongly, which forces him to take breath very often, and then he draws the flame at the same time along into the blow-pipe: this is troublesome for himself, and the experiment cools always a little at the same time. But the more experienced can breathe in through the nose, and yet at the same time blow through the pipe, whereby a constant flame from the candle is kept up. The whole art consists in constantly taking in air through the nose, and with the tongue moderating its blowing out; so that the tongue performs nearly the office of a sucker in a pump; or rather, the action of the nose, lungs, and mouth, resembles here the action of bellows with double partitions. In this manner there is no need of blowing violently, but only with a moderate and equal force; and thus the breath can never fail the operator. The only inconvenience attending it is, that the lips grow weak or tired, after having continued to blow for a while in one strain; but they soon recover their former strength by ceasing to blow for some minutes.

The

Method of  
making Ex-  
periments.

6

The candle used for this purpose ought to be snuffed often, but so that the top of the wick may retain some fat in it, because the flame is not hot enough when the wick is almost burnt to ashes; so that only the top must be snuffed off, because a low wick gives too small a flame. The blue flame is the hottest; this ought therefore to be forced out when a great heat is required, and only the point of the flame must be directed upon the subject which is to be essayed.

7

The piece of charcoal made use of in these experiments must not be of a disposition to crack. If this should happen, it must gradually be heated until it does not crack any more, before any essay is made upon it. If this be not observed, but the essay made immediately with a strong flame, small pieces of it will split off in the face and eyes of the essayer, and often throw along with them the matter that was to be essayed. Charcoal which is too much burnt consumes too quickly during the experiment, leaving small holes in it, wherein the matter to be tried may be lost; and charcoal that is burnt too little catches flame from the candle, burning by itself like a piece of wood, which likewise hinders the process.

8

Of those things that are to be essayed, only a small piece must be broke off for that purpose, not bigger than that the flame of the candle may be able to act upon it at once, if required; which is sometimes necessary; for instance, when the matter requires to be made red-hot throughout. A piece of about an eighth part of an inch square is reckoned of a moderate size, and fittest for experiments; seldom more, but rather less. This proportion is only mentioned as a direction in regard to the quantity, the figure being of no consequence at all, a piece broke off from a stone seldom or never happening to be square. But here it is to be observed, that the piece ought to be broke as thin as possible, at least the edges; the advantage thereof is easily seen, the fire having then more influence upon the subject, and the experiment being quicker made. This is particularly necessary to be observed when such stones are to be essayed, which, although in some respects fusible by themselves, yet resist considerably the action of the fire; because they may by these means be brought into fusion, at least at their edges, which else would have been very difficult if the piece had been thick.

9

Some of the mineral bodies are very difficult to keep ready upon the charcoal during the experiment, before they are made red-hot; because, as soon as the flame begins to act upon them, they spit asunder with violence, and disperse. Such often are those which are of a soft consistence, or a particular figure, and which preserve the same figure in however minute particles they are broke; for instance, the calcareous spar, the sparry gypsum, sparry fluor, white sparry lead-ore, the potters ore, (*galena tessellata*), the tessellated mock-lead or blende, &c. even all the common fluors which have no determinate figure, and most of the *minera metallorum calciformes crystallifera* or *spatiosa*: all these are not so compact as common hard stones; and therefore, when the flame is immediately pushed at them, the heat forces itself quickly through and into their clefts or pores, and causes this violent expansion and dispersion. Many of the clays are likewise apt to crack in the fire, which may be for the most part ascribed to

the humidity, of which they always retain a portion. Besides those enumerated, there may be found now and then other mineral bodies of the same quality.

Method of  
making Ex-  
periments.

The only way of preventing this inconvenience, is to heat the body as slowly as possible. It is best first of all to heat that place of the charcoal where the piece is intended to be put on, and afterwards lay it thereon; a little crackling will then ensue, but commonly of no great consequence. After that, the flame is to be blown very slowly towards it, in the beginning not directly upon, but somewhat above it, and so approaching nearer and nearer with the flame until it becomes red-hot. This will do for the most part; but there are nevertheless some substances which, notwithstanding all these precautions, it is almost impossible to keep on the charcoal. Thus the fluors are generally the most difficult; and as one of their principal characters is discovered by their effects in the fire *per se*, they ought necessarily to be tried that way. To this purpose it is best to make a little hole in the charcoal to put the fluor in, and then to put another piece of charcoal as a covering upon this, leaving only a small opening for the flame to come in at, and to look at the proof. As this stone will nevertheless mostly split and fly about, a larger piece thereof than is before-mentioned must be taken, in order to have at least something of it left.

10

But if the experiment is to be made upon a stone whose effects one does not want to see in the fire *per se*, but rather with fluxes, then a piece of it ought to be forced down into melted borax, when always some part of it will remain in the borax, notwithstanding the greatest part may sometimes fly away by cracking.

11

As the stones undergo great alterations when exposed to the fire by themselves, whereby some of their characteristics, and often the most principal, are discovered, they ought first to be tried that way; observing what has been said before concerning the quantity of the matter, direction of the fire, &c. The following effects are generally the results of this experiment, *viz.*

12

1. Calcareous earth or stone, when it is pure, does never melt by itself, but becomes white and friable, so as to break freely between the fingers; and, if suffered to cool, and then mixed with water, it becomes hot, just as common quick-lime. As in these experiments only very small pieces are used, this last effect is best discovered by putting the proof on the outside of the hand, with a drop of water to it, when instantly a very quick heat is felt on the skin. When the calcareous substance is mixed with the vitriolic acid, as in the gypsum; or with clay, as in the marle; it commonly melts by itself; yet more or less difficultly in proportion to the differences of the mixtures: the gypsum produces generally a white, and the marle a grey glass or slag. When there is any iron in it, as in white iron ore, it becomes dark, and sometimes quite black, &c.

13

2. The siliceæ never melt alone, but become generally more brittle after being burnt: such of them as are coloured become colourless, and the sooner when it does not arise from any contained metal; for instance, the topazes, amethysts, &c. some of the precious stones, however, excepted. And such as are mixed with a quantity of iron grow dark in the fire, as some of the jaspers, &c.

3. The

## Apparatus.

- Method of 3. The garnet-kind melt always into a dark slag; and sometimes so easily, that it may be brought into a round globule upon the charcoal.
- 14 4. The argillacæ, when pure, never melt, but become white and hard: the same effects follow when they are mixed with phlogiston: for instance, the soap-rock is easily cut with the knife; but, being burnt, it cuts glass, and would strike fire with the steel, if as large a piece as is necessary for that purpose could be tried in this way. The soap rocks are sometimes found of a dark brown and nearly black colour, but become white in the fire, as a piece of China ware: however, care must be taken not to push the flame from the top of the wick, there being for the most part a sooty smoke, which commonly will darken all that it touches; and if this is not observed, a mistake in the experiment might easily happen: but if it is mixed with iron, as it is sometimes found, it does not so easily part with its dark colour. The argillacæ, when mixed with lime, melt by themselves, as above-mentioned. When mixed with iron, as in the boles, they grow dark or black; and if the iron is not in too great a quantity, they melt alone into a dark slag: the same happens when they are mixed with iron and a little of the vitriolic acid, as in the common clay, &c.
- 16 5. The micacæ and asbestine become somewhat hard and brittle in the fire, and are more or less refractory, though they give some marks of fusibility.
- 17 6. The fluors discover one of their chief characteristics by giving a light, like phosphorus, in the dark, when they are slowly heated; but lose this property, as well as their colour, as soon as they are made red-hot: they commonly melt in the fire into a white opaque slag, though some of them not very easily.
- 18 7. Some sorts of the zeolites, a stone lately discovered, melt easily and foam in the fire, sometimes nearly as much as borax, and become a frothy slag, &c.
- 19 8. A great many of those mineral bodies which are impregnated with iron, as the boles, and some of the white iron ores, &c. as well as some of the other iron ores, viz. the bloodstone, are not attracted by the loadstone before they have been thoroughly roasted, &c.
- 20 After the mineral bodies have been tried in the fire by themselves, they ought to be melted with fluxes, to find out if they can be dissolved or not, and some other phenomena attending this operation. To this purpose three different kinds of salts are used as fluxes, viz. *sal fodæ*, borax, and *sal fusibile microcosmicum*.
- 21 The *sal fodæ* is not much used in these small experiments, its effects upon the charcoal rendering it for the most part improper; because, as soon as the flame begins to act upon it, it melts instantly, and is almost wholly attracted by the charcoal. When this salt is employed to make any experiment, but a very little quantity thereof is wanted at once, viz. about the cubical contents of an eighth part of an inch, more or less: this is laid upon the charcoal, and the flame blown on it with the blow-pipe; but as this salt commonly is in form of a powder, it is necessary to go on very softly, that the force of the flame may not disperse the minute particles of the salt. As soon as it begins to melt, it runs along on the charcoal almost as melted tallow; and when cold, it is a glassy matter of an opaque dull colour spread on the coal. The moment it is melted, the matter which is to be tried ought to be put into it, because otherwise the greatest part of the salt will be soaked into the charcoal, and too little of it left for the intended purpose: the flame ought then to be directed on the matter itself, and if the salt spreads too much about, leaving the proof almost alone, it may be brought to it again by blowing the flame on its extremities, and directing it towards the subject of the experiment. In the essays made with this salt, it is true, we may find if the mineral bodies which are melted with it have been dissolved by it or not; but we cannot tell with any certainty whether this is done hastily and with force, or gently and slowly; whether only a less or a greater part of the matter has been dissolved; nor can it be well distinguished if the matter has imparted any weak tincture to the slag; because this salt always bubbles upon the charcoal during the experiment, nor is it clear when cool; so that scarce any colour, except it be a very deep one, can be discovered, although it may sometimes be coloured by the matter that has been tried.
- 22 The two other salts, viz. the borax, and the *sal fusibile microcosmicum*, are very well adapted to these experiments, because they may by the flame be brought to a clear uncoloured and transparent glass; and as they have no attraction to the charcoal, they keep themselves always upon it in a round globular form. The *sal fusibile microcosmicum* is very scarce, and not to be met with in the shops; it is made of urine. For its preparation, see CHEMISTRY, n° 308.
- 23 The quantity of these two salts required for an experiment is almost the same as the *sal fodæ*; but as these salts are crystallised, and consequently include a great deal of water, particularly the borax, their bulk is considerably reduced when melted, and therefore little more may be taken than the before-mentioned quantity.
- 24 The borax and microcosmic salt, when exposed to the flame of the blow-pipe, bubble very much and foam before they melt to a clear glass; but more so the borax, which for the most part depends on the water they contain: and as this would hinder the essayer to make due observations on the phenomena of the experiment, the salt which is to be used must first be brought to clear glass before it can serve as a flux; it must therefore be kept in the fire until it is become so transparent that the cracks in the charcoal may be seen thro' it. This done, whatsoever is to be tried, is put to it, and the fire continued.
- 25 Here it is to be observed, that for the essays made with any of these two fluxes on mineral bodies, no larger pieces of these must be taken than that all together they may keep a globular form upon the charcoal; because then it may be better distinguished in what manner the flux acts upon the matter during the experiment: if this is not observed, the flux, communicating itself with every point of the surface of the mineral body, spreads all over it, and keeps the form of this last, which commonly is flat, and by that means hinders the operator to observe all the phenomena which may happen. Besides, the flux being in too small a quantity, in proportion to the body to be tried, is too weak to act with all its force upon it. The best proportion, therefore, is about a third part of the mineral body to the flux. And, as the quantity of the flux (21, 23) makes a globe of a due size, in regard to the greatest

Method of  
making Ex-  
periments.

greatest heat that it is possible to procure in these experiments, the size of the mineral body (8) required when it is to be tried in the fire by itself, is too large on this occasion, the third part of it being here almost sufficient.

92 The sal sodæ, as has been said before, is not of much use in these experiments; nor has it any particular qualities in preference to the two last-mentioned salts, except that it dissolves the zeolites easier than the borax and the *sal fusibile microscopicum*.

This last-mentioned salt shews almost the same effects in the fire as the borax; and differs from this in very few circumstances, of which one of the principal is, that, when melted with manganese, it becomes of a crimson hue, instead of a jacinth colour, which borax takes.

This salt is, however, for its scarcity, still very little in use, borax alone being that which is commonly used. Whenever a mineral body is melted with of these two last mentioned salts, in the above-described manner, it is easily seen whether it is quickly dissolved; because in that case an effervescence arises, which lasts till the whole is dissolved; or whether this is slowly done, in which case few and small bubbles only rise from the matter: likewise, if it cannot be dissolved at all; because then it is observed only to turn round in the flux without the least bubble, and the edges look as sharp as they were before.

27 In order further to illustrate what has been said about these experiments, we shall mention some instances concerning the effects of borax upon the mineral bodies, *viz.*

28 1. The calcareous substances, and all those stones which contain any thing of lime in their composition, dissolve readily, and with effervescence, in the borax: this effervescence is the more violent, the greater the portion of lime contained in the stone. This, however, is not the only reason in the gypsum, because both the constituents of this do readily mix with the borax, and therefore a greater effervescence arises in melting gypsum with the borax than lime alone.

29 2. The siliceæ do not dissolve, unless some few, which contain a quantity of iron.

30 3. The argillaceæ, when pure, are not acted upon by the borax; but when they are mixed with some heterogeneous bodies, they are dissolved, though very slowly; such is, for instance, the stone marrow, the common clay, &c.

31 4. The granatæ, zeolites, and trapp, dissolve but slowly.

32 5. The fluores, asbestinæ, and micacæ, dissolve for the most part very easily; and so forth.

33 Some of these bodies melt to a colourless transparent glass with the borax; for instance, the calcareous substances when pure, the fluors, some of the zeolites, &c. Others tinge the borax with a green transparent colour; *viz.* the granatæ, trapp, some of the argillaceæ, some of the micacæ and asbestinæ: this green has its origin, partly from a small portion of iron which the granatæ particularly contain, and partly from phlogiston.

34 The borax cannot dissolve but a certain quantity of a mineral body proportional to its own. Of the calcareous kind it dissolves a vast quantity; but turns at last, when too much has been added, from a clear,

transparent, to a white opaque slag. When the quantity of the calcareous matter exceeds but little in proportion, the glass looks very clear as long as it remains hot; but as soon as it begins to cool, a white half opaque cloud is seen to arise from the bottom, which spreads over the third, half, or more of the glass globe, in proportion to the quantity of calcareous matter; but the glass or slag is nevertheless shining, and of a glassy texture when broke: if more of this matter be added, the cloud rises quicker and more opaque, and so by degrees till the slag becomes quite milk-white: it is then no more of a shining, but rather dry appearance, on the surface; is very brittle, and of a grained texture when broke.

All that has been said hitherto of experiments upon mineral bodies, is only concerning the stones and earths. We now proceed to the metals and ores, in order to describe the manner of examining these bodies, and particularly the management of the blow-pipe in these experiments. An exact knowledge and nice proceeding are so much the more necessary here, as the metals are often so much dignified in their ores as to be very difficultly known by their external appearance, and liable sometimes to be mistaken one for the other: some of the cobalt ores, for instance, resemble much a pyrites arsenicalis; there are also some iron and lead ores which are nearly like one another, &c.

As the ores generally consist of metals mineralised with sulphur or arsenic, or sometimes both together; they ought first to be exposed to the fire by themselves in order not only to determine with which of them they are mineralised, but also to set them free from these volatile mineralising bodies: And this also serves instead of calcination, by which they are prepared for further essays.

Here it must be observed, that, whenever any metal or fusible ore is to be tried, a little concavity must be made in that place of the charcoal where the matter is to be put; because, as soon as it is melted, it forms itself into a globular figure, and might then roll from the charcoal, if its surface was plain; but when borax is put to it, this inconvenience is not so much to be feared.

Whenever an ore is to be tried, a small bit is broke off for that purpose, of such a size as has been directed; this bit is laid upon the charcoal, and the flame blown on it slowly: Then the sulphur or arsenic begins to part from it in form of smoke; these are easily distinguished from one another by their smell, that of sulphur being sufficiently known, and the arsenic smelling like garlic. The flame ought to be blown very softly, as long as any smoke is seen to arise from the ore; but after that the heat must be augmented by degrees, in order to make the calcination as perfect as possible. If the heat is applied very strong from the beginning upon an ore that contains much of the sulphur or arsenic, this ore will presently melt, and yet lose very little of its mineralising bodies, and by that means render the calcination very imperfect. It is, however, impossible to calcine the ores in this manner to the utmost perfection, which is easily seen in the following instance, *viz.* in melting down a calcined potter's ore with borax, it will be found to bubble upon the coal, which depends on the sulphur

Method of  
making Ex-  
periments.

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Of Experiments.

Of Experiments.

luphur which is still left, the vitriolic acid of this uniting with the borax, and causing this motion. However, lead, in its metallic form, melted in this manner, bubbles alone upon the charcoal, if any sulphur remains in it. But as the lead, as well as some of the other metals, may raise bubbles upon the charcoal, although they are quite free from the sulphur, only by the flame's being forced too violently on it, these phenomena ought not to be confounded with each other.

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The ores being thus calcined, the metals contained in them may be discovered, either by being melted alone, or with fluxes: when they shew themselves either in their pure metallic state, or by tinging the slag with colours peculiar to each of them. In these experiments, it is not to be expected that the quantity of metal contained in the ore should be exactly determined; this must be done in larger laboratories. This cannot, however, be looked upon as any defect, since it is sufficient for a mineralogist only to find out what sort of metal is contained in the ore. There is another circumstance which is a more real defect in our little laboratory, which is, that some ores are not at all able to be tried in it by so small an apparatus: for instance, the gold ore called *pyrites aureus*, which consists of gold, iron, and sulphur. The greatest quantity of gold which this ore contains is about one ounce, or one ounce and an half, out of 100 pounds of the ore, the rest being iron and sulphur; and as only a very small bit is allowed for these experiments, the gold contained therein can hardly be discerned by the eye, even if it could be extracted; but it goes along with the iron in the slag, this last metal being in so large a quantity in proportion to the other, and both of them being capable of mixture with each other.

All the kinds of blende, black-jack, which are mineralized zinc ores, containing zinc, sulphur, and iron, cannot be tried this way, because they cannot be perfectly calcined; and besides, the zinc flies off, when the iron scorifies: neither can all those blendes which contain silver or gold mineralized with them, be tried in this manner, which is particularly owing to the imperfect calcination: nor are the quicksilver ores fit for these experiments; the volatility of this semi-metal making it impossible to bring it out of the poorer sort of ores; and the rich ores which sweat out the quicksilver, when kept close in the hand, not wanting any of these essays, &c. Those ores ought to be essayed in larger quantities, and by methods which cannot be applied upon a piece of charcoal.

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Some of the rich silver ores are easily tried: for instance, *minera argenti vitrea*, commonly called *silver-glass*, which consists only of silver and sulphur. When this ore is exposed to the flame, it melts instantly, and the sulphur goes away in fume, leaving the silver pure upon the charcoal, in a globular form. If this silver should happen to be of a dirty appearance, which often is the case, then it must be melted anew with a very little borax; and after it has been kept in fusion for a minute or two, so as to be perfectly melted and red-hot, the proof is suffered to cool: it may then be taken off the coal, and being laid upon the steel-plate, the silver is separated from the slag by

one or two strokes of the hammer. Here the use of the iron ring is manifest; for this ought first to be placed upon the plate, to hinder the proof from flying off by the violence of the stroke, which otherwise would happen. The silver is then found inclosed in the slag of a globular form, and quite shining, as if it were polished. When a large quantity of silver is contained in a lead ore, viz. in a potter's ore, it can likewise be discovered through the use of the blow-pipe.

Of the pure tin ores, the tin may be melted out in its metallic state. Some of these ores melt very easily, and yield their metal in quantity, if only exposed to the fire by themselves: but others are more refractory, and as these melt very slowly, the tin, which sweats out in form of very small globules, is instantly burnt to ashes, before these globules have time to unite in order to compose a larger globe which might be seen by the eye, and is not so soon destroyed by the fire; it is therefore necessary to add a little borax to these from the beginning, and then to blow the flame violently at the proof. The borax does here preserve the metal from being too soon calcined; and even contributes to the reader collecting of the small metallic particles, which soon are seen to form themselves into a globe of metallic tin at the bottom of the whole mass, nearest to the charcoal. As soon as so much of metallic tin is produced as is sufficient to convince the operator of its presence, the fire ought to cease, although not the whole of the ore be yet melted; because seldom, or rather never, the whole of this kind of ore can be reduced into metal by means of these experiments, a great deal thereof always being calcined: and if the fire is continued too long, perhaps even the metal, already reduced, may likewise be burnt to ashes; for the tin is very soon calcined by the fire.

Most part of the lead ores may be brought to a metallic lead upon the charcoal. The *minera plumbi calciformis*, which are pure, are easily melted into lead: but such of them as are mixed with an *ochra ferri*, or any kind of earth, as clay, lime, &c. yield very little of lead, and even nothing at all, if the heterogenea are combined therewith in any large quantity: this happens even with the *minera plumbi calciformis arsenica mixta*. These, therefore, are not to be tried but in larger laboratories. However, every mineral body suspected to contain any metallic substance, may be tried by the blow-pipe, so as to give sufficient proofs whether it contains or not, by its effects being different from those of the stone or earths, &c.

The *minera plumbi mineralifata* leave the lead in a metallic form, if too large a quantity of iron be not mixed with it. For example, when a tessellated or steel-grained lead-ore is exposed to the flame, its sulphur, and even the arsenic, if there be any, begins to fume, and the ore itself immediately to melt into a globular form; the rest of the sulphur continues then to fly off, if the flame is blown slowly upon the mass; instead of that, very little of the sulphur will go off, if the flame is forced violently on it: in this case, it rather happens that the lead itself crackles and dissipates, throwing about very minute metallic particles.

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The sulphur being driven out as much as possible, which is known by finding no sulphureous vapour in smelting at the proof, the whole is suffered to cool, and then a globule of metallic lead will be left upon the coal. If any iron is contained in the lead ore, the lead which is melted out of it is not of a metallic shining, but rather of a black and uneven surface: a little borax must in this case be melted with it, and as soon as no bubble is seen to rise any longer from the metal into the borax, the fire must be discontinued: when the mass is grown cold, the iron will be found scorified with the borax, and the lead left pure and of a shining colour.

The borax does not scorify the lead in these small experiments, when it is pure: if the flame is forced with violence on it, a bubbling will ensue, resembling that which is observed when borax dissolves a body melted with it; but when the fire ceases, the slag will be perfectly clear and transparent, and a quantity of very minute lead particles will be seen spread about in the borax, which have been torn off from the mass during the bubbling.

If such a lead ore is rich in silver, this last metal may likewise be discovered by this experiment; because, as the lead is volatile, it may be forced off, and the silver remain. To effect this, the lead, which is melted out of the ore, must be kept in constant fusion with a slow heat, that it may be consumed. This end will be sooner obtained, and the lead part quicker, if, during the fusion, the wind through the blow-pipe be directed immediately, though not forcibly, upon the melted mass itself, until it begins to cool, then the fire must be directed on it again. The lead, which is already in a volatilising state, will by this artifice be driven out in form of a subtle smoke; and by thus continuing by turns to melt the mass, and then to blow off the lead, as has been said, until no smoke is any longer perceived, the silver will at last be obtained pure. The same observation holds good here also which was made about the gold, that, as none but very little bits of the ores can be employed in these experiments, it will be difficult to extract the silver out of a pure ore; for some part of it will fly off with the lead, and what might be left is too little to be discerned by the eye. The silver which by this means is obtained is easily distinguished from lead by the following external marks, viz. that it must be red-hot before it can be melted: it cools sooner than lead: it has a silver colour; that is to say, brighter and whiter than lead: and is harder to beat with the hammer.

The *minera cupri calciformis*, (at least some of them) when mixed with too much stone or earth, are easily reduced to copper with any flux: if the copper is found not to have its natural bright colour, it must be melted with a little borax, which purifies it. Some of these ores do not at all discover their metal, if not immediately melted with borax; the heterogenea contained in them hindering the fusion, before these are scorified by the flux.

The grey copper ores, which only consist of copper and sulphur, are tried almost in the same manner as the preceding. Being exposed to the flame by themselves, they will be found instantly to melt, and part of their sulphur to go off. The copper may after-

wards be obtained in two ways: the one, by keeping the proof in fusion for about a minute, and then suffering it to cool; when it will be found to have a dark and uneven appearance externally, but which, after being broke, discovers the metallic copper of a globular form in its centre, surrounded with a regule, which still contains some sulphur and a portion of the metal: the other, by being melted with borax, which last way sometimes makes the metal appear sooner.

The *minera cupri pyritacea*, containing copper, sulphur, and iron, may be tried with the blow-pipe, if they are not too poor: in these experiments the ore ought to be calcined, and after that the iron scorified. For this purpose a bit of the ore must be exposed to a slow flame, that as much of the sulphur as possible may part from it before it is melted; because the ore commonly melts very soon, and then the sulphur is more difficult to drive off. After being melted, it must be kept in fusion with a strong fire, for about a minute, that a great part of the iron may be calcined: and, after that, some borax must be added, which scorifies the iron, and turns with it to a black slag. If the ore is very rich, a metallic copper will be had in the slag, after the scorification: if the ore is of a moderate richness, the copper will still retain a little sulphur, and sometimes iron: the product will therefore be brittle, and must with great caution be separated from the slag, that it may not break into pieces; and if this product is afterwards treated in the same manner as before said, in speaking of the grey copper ores, the metal will soon be produced. But, if the ore is poor, the product after the first scorification must be brought into fusion, and afterwards melted with some fresh borax, in order to calcine and scorify the remaining portion of iron; after which it may be treated as mentioned n<sup>o</sup> 47. The copper will, in this last case, be found in a very small globule.

The copper is not very easily scorified with this apparatus, when it is melted together with borax; unless it has first been exposed to the fire by itself for a while, in order to be calcined. When only a little of this metal is dissolved, it instantly tinges the slag of a reddish-brown colour, and mostly opaque; but as soon as this slag is kept in fusion for a little while, it becomes quite green and transparent: and thus the presence of the copper may be discovered by the colour, when it is concealed in heterogeneous bodies, so as not to be discovered by any other experiment.

If metallic copper is melted with borax by a slow fire, and only for a very little time, the glass, or slag, becomes of a fine transparent blue or violet colour, inclining more or less to the green: but this colour is not properly owing to the copper, but it may rather be to its phlogiston; because the same colour is to be had in the same manner from iron: and these glasses which are coloured with either of these two metals, soon lose their colour if exposed to a strong fire, in which they are made quite clear and colourless. Besides, if this glass, tinged blue with the copper, is again melted with more of this metal, it becomes of a good green colour, which for a long time keeps unchanged in the fire.

The iron ores, when pure, can never be melted by themselves, through the means of the blow-pipe alone; nor

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nor do they yield their metal, when melted with fluxes, because they require too strong a heat to be brought into fusion; and, as both the ore and the metal itself very soon lose their phlogiston in the fire, and cannot be supplied with a sufficient quantity from the charcoal, so likewise they are very soon calcined in the fire. This easy calcination is also the reason why the fluxes, for instance borax, readily scorify this ore, and even the metal itself. The iron loses its phlogiston in the fire sooner than the copper, it is therefore easier scorified; and this is the principle on which the experiment mentioned n<sup>o</sup> 48. is founded.

comes very deep; and thus the colour may be altered, according to pleasure.

When the cobalt ore is pure, or at least contains but little iron, a cobalt regulus is almost instantly produced in the borax, during the fusion: but when it is mixed with a quantity of iron, this last metal ought first to be separated, which is easily performed, since it scorifies sooner than the cobalt; therefore, as long as the slag retains any brown or black colour (55.) it must be separated, and melted again with fresh borax, until it shew the colour.

Nickel is very seldom to be had, as its ores are seldom free from mixtures of other metals. It is very difficultly tried with the blow-pipe. However, when this semi-metal is mixed with iron and cobalt, it is easily freed from these heterogeneous metals, and reduced to a pure nickel regulus, by means of scorification with borax, in the same manner as is mentioned (46.), because both the iron and cobalt sooner scorify than the nickel. The regulus of nickel itself is of a green colour, when calcined: it requires a pretty strong fire before it melts, and tinges the borax with a jacinth colour. Manganese gives the same colour to borax; but its other qualities are quite different, so as not to be confounded with the nickel.

Thus we have briefly described the use of the blow-pipe, and the method of employing it in the study of mineralogy. Any gentleman who is a lover of this science, will, by attending to the rules here laid down, be able in an easy manner to amuse himself in discovering the properties of those works of nature which the mineral kingdom furnishes us with. The husbandman may by its help find out what sorts of stones, earths, ores, &c. there are on his estate, and to what economical uses they may be employed. The scientific mineralist may, by examining into the properties and effects of the mineral bodies, discover the natural relation these bodies stand in to each other, and thereby furnish himself with materials for establishing a mineral system, founded on such principles as nature herself has laid down in them; and this in his own study, without being forced to have recourse to large laboratories, crucibles, furnaces, &c. which is attended with a great deal of trouble, and is the reason why so few can have an opportunity of gratifying their desire of knowledge in this part of natural history. It is to be hoped, that the more general its use becomes, the more and sooner will its imperfections be removed, and such additions made as may be found necessary and convenient. We shall now add some hints towards these improvements, leaving to the judicious practitioner the manner of completing them.

A greater number of fluxes might perhaps be found out, whose effects on mineral bodies might be different from these already in use, whereby more distinct characters of those mineral bodies might be discovered, which now either shew ambiguous ones, or which are almost impossible to be exactly tried by the blow-pipe. Instead of the sal soda, some other salts might be found out, more fit for these experiments. But it is very necessary not to make use of any other fluxes than such as have no attraction to the charcoal: if they at the same time are clear and transparent when melted, as the borax and *sal fusibile microcosmicum*, it is still bet-

52 The iron is, however, discovered without much difficulty, although it be mixed but in a very small quantity with heterogeneous bodies. The ore, or those bodies which contain any large quantity of the metal, are all attracted by the loadstone, some without any previous calcination, and others not till after having being roasted. When a clay is mixed with a little iron, it commonly melts by itself in the fire; but, if this metal is contained in a limestone, it does not promote the fusion, but gives the stone a dark, and sometimes a deep black colour, which always is the character of iron. A *minera ferri calciformis pura crystallifata*, is commonly of a red colour: this being exposed to the flame, becomes quite black; and is then readily attracted by the loadstone, which it was not before. Besides these signs, the iron discovers itself, by tinging the slag of a green transparent colour, inclining to brown, when only a little of the metal is scorified; but as soon as any large quantity thereof is dissolved in the slag, this becomes first a blackish brown, and afterwards quite black and opaque.

53 Bismuth is known by its communicating a yellowish-brown colour to borax; and arsenic by its volatility, and garlick smell. Antimony, both in form of regulus and ore, is wholly volatile in the fire, when it is not mixed with any other metal (except arsenic), and is known by its particular smell; easier to be distinguished, when once known, than described. When the ore of antimony is melted upon the charcoal, it bubbles constantly during its volatilising.

54 Zinc ores are not easily tried upon the coal (n<sup>o</sup> 39.) But the regulus of zinc, exposed to the fire upon the charcoal, burns with a beautiful blue flame, and forms itself almost instantly into white flowers, which are the common flowers of zinc.

55 Cobalt is particularly remarkable for giving to the glass a blue colour, which is the zaffre or smalt. To produce this, a piece of cobalt ore must be calcined in the fire (36, 37.) and afterwards melted with borax. As soon as the glass, during the fusion, from being clear, seems to grow opaque it is a sign that it is already tinged a little; the fire is then to be discontinued, and the operator must take hold, with the nippers, of a little of the glass whilst yet hot, and draw it out slowly in the beginning, but afterwards very quick, before it cools, whereby a thread of the coloured glass is procured, more or less thick, on which the colour may easier be seen against the day or candle light than if it were left in a globular form. The thread melts easily if only put in the flame of the candle, without the help of the blow-pipe.

If this glass is melted again with more of the cobalt, and kept in fusion for a while, the colour be-

ter: however, the transparency or opacity are of no great consequence, if a substance is effayed only in order to discover its fusibility, without any attention to its colour: in which case, some metallic slag perhaps might be useful.

60 When such ores are to be reduced whose metals are very apt to calcine, such as tin, zinc, &c. it might perhaps be of service to add some phlogiston, since the charcoal cannot afford enough of it in the open fire of these effays: such a phlogiston might be the hard resin, or some such body. The manner of melting the volatile metals out of their ores *per descensum* might also perhaps be imitated: for instance, a hole might be made in the charcoal, wide above, and very narrow at the bottom; a little piece of ore being then laid at the upper end of the hole, and covered with some very small pieces of the charcoal, the flame must be directed on the top: the metal might, perhaps, by this method gather in the hole below, removed from the violence of the fire, particularly if the ore is very fusible, &c.

61 The use of the pocket laboratory, as here described, is chiefly calculated for a travelling mineralist. But a person who is always residing at one and the same place, may by some small alteration make it more commodious to himself, and avoid the trouble of blowing with the mouth. For this purpose he may have the blow-pipe go through a hole in a table, and fixed underneath to a small pair of bellows with double bottoms, such as some of the glass-blowers use, and then nothing more is required than to move the bellows with the feet during the experiment; but in this case a lamp may be used instead of a candle. This method would be attended with a still greater advantage, if there were many such parts as fig. 2. n<sup>o</sup> 2. (Plate v. Vol. II.) the openings of which were of different dimensions: these parts might by means of a screw be fastened to the main body of the blow-pipe, and taken away at pleasure. The benefit of having these nozzles of different capacities at their ends, would be that of exciting a stronger or weaker heat as occasion might require. It would only be necessary to observe, that in proportion as the opening of the pipe (nozzle) is enlarged, the quantity of the flame must be augmented by a thicker wick in the lamp, and the force of blowing increased by means of weights laid on the bellows. A much more intense heat would thus be procured by a pipe of a considerable opening at the end, by which the experiments might undoubtedly be carried farther than with the common blow-pipe.

62 A traveller, who has seldom an opportunity of carrying many things along with him, may very well be contented with this pocket laboratory, and its apparatus, which is sufficient for most part of such experiments as can be made on a journey. There are, however, other things very useful to have at hand on a journey, which ought to make a second part of the pocket-laboratory, if the manner of travelling does not oppose it: this consists of a little box including the different acids, and one or two matrasces, in order to try the mineral bodies in liquid menstria, if required.

63 These acids are, the acid of nitre, of vitriol, and of common salt. Most of the stones and earths are attacked, at least in some degree, by the acids; but the

calcareous are the easiest of all to be dissolved by them, which is accounted for by their calcareous properties. The acid of nitre is that which is most used in these experiments; it dissolves the limestone, when pure, perfectly, with a violent effervescence, and the solution becomes clear: when the limestone enters into some other body, it is nevertheless discovered by this acid, through a greater or lesser effervescence in proportion to the quantity of the calcareous particles, unless these are so few as to be almost concealed from the acid by the heterogeneous ones. In this manner, a calcareous body, which sometimes nearly resembles a siliceous or argillaceous one, may be known from these latter, without the help of the blow-pipe, only by pouring one or two drops of this acid upon the subject, which is very convenient when there is no opportunity nor time for using this instrument.

The gypsum, which consist of lime and the vitriolic acid, are not in the least attacked by the acid of nitre, if they contain a sufficient quantity of their own acid, because the vitriolic acid has a stronger attraction to the lime than the acid of nitre: but if the calcareous substance is not perfectly saturated with the acid of vitriol, then an effervescence arises with the acid of nitre, more or less in proportion to the want of the vitriolic acid. These circumstances are often very essential in distinguishing the calcarei and gypsum from one another.

The acid of nitre is likewise necessary in trying the zeolites, of which some species have the singular effect to dissolve with effervescence in the abovementioned acid; and within a quarter of an hour, or even sometimes not until several hours after, to change the whole solution into a clear jelly, of so firm a consistence, that the glass, wherein it is contained, may be reversed, without its falling out.

If any mineral body is tried in this menstruum, and only a small quantity is suspected to be dissolved, tho' it was impossible to distinguish it with the eye during the solution, it can easily be discovered by adding to it *ad saturitatem* a clear solution of an alkali, when the dissolved part will be precipitated, and fall to the bottom. For this purpose the sal sodæ may be very useful.

The acid of nitre will suffice for making experiments upon stones and earths; but if the experiments are to be extended to the metals, the other two acids are also necessary. As the acids are very corrosive, they must not be kept in the ordinary pocket-laboratory, already described, for fear of spoiling the other apparatus, if the stoppers should happen not to fit exactly to the necks of the bottles, and some of the acid should be spilt.

For these acids a separate box must be made, which is eight inches and three quarters long, four inches broad, and five inches high (A). In this box are three long and narrow bottles, containing the acids, placed upright at one end of it, two glass matrasces laid horizontally in the upper part, and a little drawer underneath, made on purpose to fill the empty room below the matrasces, and to give the box a regular form; and as charcoal is not every where to be met with in travelling, a piece ought always to be kept in this drawer for the use of the blow-pipe.

(A) But these dimensions, originally directed, have been since reduced, as mentioned under n<sup>o</sup> 3. par. *penult.*

In order to keep the acids more close in the bottles, since the glass-stopper is not always sufficient, there is a glass-cover besides, made so as to screw round the neck of the bottle; and if this is nicely made, nothing can come through, though the box be inclined, or even reversed, which sometimes may happen. The form of the glass matrasses is seen fig. 4. They ought to be very thin at the bottom, that they may not crack by being suddenly put over the fire or taken off it. In these matrasses solutions may very easily be made over the flame of a candle: every mineral body capable of being affected by the acids in this degree of heat, may here be dissolved, and particularly the metals.

Another instrument is likewise necessary to a complete pocket-laboratory, viz. a washing-trough; in which the mineral bodies, and particularly the ores, may be separated from each other, and from the adherent rock, by means of water.

This trough is very common in the laboratories, and is used of different sizes; but here only one is required of a moderate size, such as twelve inches and a half long, three inches broad at the one end, and one inch and a half at the other end (a), sloping down from the sides and the broad end to the bottom, where it is three quarters of an inch deep: we have given a figure of it in fig. 5. It is commonly made of wood, which ought to be chosen smooth, hard, and compact, wherein are no pores in which the minute grains of the pounded matter may conceal themselves.

It is to be observed, that if any matter is to be washed which is suspected to contain some native metal, as silver or gold; a trough should be procured for this purpose, of a very shallow slope, because the minute particles of the native metal have then more power to assemble together at the broad end, separate from the other matter.

The magnagement of this trough, or the manner of washing, consists chiefly in this: that when the matter is mixed with about three or four times its quantity of water in the trough, this is kept very loose between two fingers of the left hand, and some light strokes given on its broad end with the right, that it may move backwards and forwards, by which means the heaviest particles assemble at the broad and upper end, from which the lighter ones are to be separated by inclining the trough and pouring a little water on them. By repeating this process, all such particles as are of the same gravity may be collected together, separate from those of a different gravity, provided they all were before equally pounded; though such as are of a clayish nature, are often very difficult to separate from the rest, which, however, is of no great consequence to a skilful and experienced washer. The washing process is very necessary, as there are often rich ores, and even native metals, found concealed in earths and sand in so minute particles, as not to be discovered by any other means.

#### ARRANGEMENT of Mineral Bodies.

THE bodies belonging to the mineral kingdom are divided into four different classes, viz.

1. *Earths*, or those substances which are not ductile, are mostly indissoluble in water or oil, and pre-

serve their constitution in a strong heat (c).

2. *Salts*: these dissolve in water, and give it a taste, and when the quantity of water required to keep them in dissolution is evaporated, they concrete again into solid and angular bodies.
3. *Inflammables*, which can be dissolved in oils, but not in water, and are inflammable.
4. *Metals*, the heaviest of all bodies; some of which are malleable, and some can be decomposed.

Here, however, it must be observed, that these classes are blended one with another; and therefore some exceptions must be allowed in every one of them: for instance, in the first class, the calcareous earth is in some measure dissoluble in water, and pipe-clay with some others diminish somewhat in their bulk when kept for a long time in a calcining heat. In the third class, the calx of arsenic has nearly the same properties as salts; and there is no possible definition of salt, that can exclude the arsenic, though at the same time it is impossible to arrange it elsewhere than among the semi-metals. In the fourth class it is to be observed, that the metals and semi-metals, perfect or imperfect, have not the same qualities common to them all; because some of them may be calcined, or deprived of their phlogiston, in the same degree of fire in which others are in the least changed, unless particular artifices or processes are made use of: some of them also may be made malleable, while others are by no means to be rendered so. That the convex surface metals take after being melted, is a quality not particularly belonging to them, because every thing that is perfectly fluid in the fire, and has no attraction to the vessel in which it is kept, or to any added matter, takes the same figure; as we find borax, *sal fusibile microscopicum*, and others do, when melted upon a piece of charcoal: therefore, with regard to all that has been said, it is hardly worth while to invent such definitions as shall include several species at once; we ought rather to be content with perfectly knowing them separately.

#### THE FIRST CLASS.

*EARTHS*, are those mineral bodies, not ductile, for the most part not dissoluble in water or oils, and that preserve their constitution in a strong heat.

These earths are here arranged according to their constituent parts, so far as hitherto discovered, and are divided into nine orders.

#### THE FIRST ORDER.

THE *Calcareous* kinds. These, when pure, and free from heterogeneous matters, have the following qualities common to them all:

1. That they become friable when burnt in the fire, and afterwards fall into a white powder.
2. That their falling into powder is promoted, if, after being burnt, they are thrown into water, whereby a strong heat arises, and a partial solution.
3. They cannot be melted by themselves into glass in the strongest fire.
4. When burnt, they augment the causticity of the lixivium of potashes.

5. They

(a) Reduced dimensions are mentioned under n<sup>o</sup> 3. par *ult.*

(c) By *earths*, the author (Mr Cronstedt) does not mean (strictly speaking) only earths, but includes all the kinds of stones or fossils not inflammable, saline, or metallic.

5. They are dissolved in acids with effervescence, in the following manner :

- a. The acid of vitriol partly unites with them, and forms a precipitate, which is a gypseous earth; and partly shoots into fensitical crystals with that which is kept dissolved, after a due evaporation.
  - b. With the acid of common salt they make a sal ammoniacum fixum, which also partly precipitates itself.
  - c. The acid of nitre dissolves them perfectly, and does not part with them again, unless some alkaline salt is added.
6. They melt easily with borax into a glass, which suffers impressions in a degree of heat below ignition.
7. They likewise fuse into a glass with *sal fusibile microscopicum* with an effervescence (D)
8. They melt the readiest of all kinds of stones, with the calces, into a corrosive glass or slag.
9. They have also some power of reducing certain metallic earths or calces; for instance, those of lead and of bismuth, and likewise, tho' in a less degree, those of copper and of iron: thus,
10. Do they, in this last-mentioned article (9.), as well as in other circumstances, resemble a fixed alkaline salt; from whence also this whole kind is very often, and properly, called *alkaline earths*.

\* The calcareous earth is found,

74

I. Pure,

1. In form of powder. *Agaricus mineralis*, or *lac lune*.

a. White, is found in moors, and at the bottom of lakes.

b. Red.

c. Yellow.—This kind of earth seems to be an impalpable powder of mouldered limestones abraded and collected by the waters, and is therefore common in the neighbourhoods where limestones are found: and tho' the stone be at some distance, which is sometimes the case, still nothing contradictory appears in this opinion of the origin of this species; since in that case it has only been carried farther by the greater rapidity of a stronger current of water. When this earth is found in the clefts of rocks, it receives more pompous names; such as *gur*, *lac lune*, &c. It burns readily into lime, if it is previously stamped, that it may better cohere: it is then, or in its native state, used for white-washing, but easily rubs off by the least touch. At certain places in the province of Smoland in Sweden, there is found in the moors a white earth, which, by its external appearance, resembles the species here described; but it does not show any marks of effervescence with acids, nor does it burn into lime. It were to be wished, that those who have an opportunity of getting any quantity of this latter earth, would undertake to examine it better.

2. Friable and compact. Chalk, *creta*.

a. White, *creta alba*, is found in England, France,

75

and in the province of Skone in Sweden, in which last place it is only found adherent to flint. In the two first kingdoms there are large strata of this substance, in which flint is imbedded. This seems to indicate, that the loose flints, or those dispersed on the surface of the earth, have been by some causes carried from their native beds; but, as yet, no one can prove, that chalk and flint are of the same constituent parts.—Chalk is, however a vague name, also applied to other earths; whence we hear of chalks of various colours; but there are none which are known to be of a calcareous nature, except this kind here described, and of which there are no other varieties, otherwise than in regard to the looseness of the texture, or the fineness of the particles.

3. Indurated, or hard; *Terra calcarea indurata*. Limestone; *Lapis calcareus*. 76

A. Solid, of no visible particles, or not granulated.

This kind varies in regard to hardness and colour;

a. White.

b. Whitish yellow.

c. Flesh-coloured, found in loose masses.

d. Reddish brown.

e. Grey.

f. Variegated with many colours, and particularly called *marble*.

g. Black.

B. Grained or granulated limestone; *Lapis calcareus particuli granulati*. 77

1. Coarse-grained and of a loose texture, called *salt-slag* in Swedish, from its resemblance to lumps of salt.

a. Reddish yellow. b. White.

The grained flux spar is also sometimes called *salt-slag*.

2. Fine-grained.

a. White. b. Semi-transparent, from Solfatara in Italy, in which native brimstone is found.

3. Very fine grained.

a. White and green.

b. White and black.—This species has often as beautiful colours as those commonly called *marbles*; but the texture and coherency of its particles will not admit of a good polish.

C. Scaly limestone; *Lapis calcareus particuli squamosi sive spatiosi*. 78

1. With coarse or large scales.

a. White.

Some kinds of this lose in a calcining heat 40 per cent. of their weight; and, exposed to the air, get a brownish efflorescence, a sign that they contain some iron, and are a medium between a limestone and the white iron ore called *stahlsteine*; nor do they excite any effervescence with acids in their crude state.

b. Reddish yellow.

2. With small scales.

a. White.

3. Fine glittering or sparkling.

a. White.

(D) This effervescence is also made with the borax, as well as with this *sal fusibile microscopicum*; and it is also to be observed, that the glasses made with these salts are quite colourless and transparent.

a. White.

b. Of many colours. This variety constitutes a great number of the foreign marbles.

This species of limestone takes a good polish, and is therefore used as marble whenever it is found of a fine colour. It is besides to be remarked, that the grained and scaly limestones are found either in veins, or form whole mountains, that shew no strata, nor signs of petrifications.

D. Lime or calcareous spar.

(1.) Of a rhomboidal figure.

a. Transparent or diaphanous.

1. Refracting spar; *Spatum islandicum*.

This represents the objects seen through it double.

2. Common spar, which shews the object single.

1. White, or colourless.

2. Yellowish and phosphorescent.

b. Opaque; *Spatum rhomboidale opacum*.

1. White, is found in many places, mostly in clefts, and among crystallisations.

2. Black.

3. Brownish yellow.

(2.) Foliated or plated spar.

This has no rhomboidal figure, but breaks into thin plates, so placed as to be not unlike sheets of thin paper, laid over each other.

a. Opaque white.

E. Crystallised calcareous spars. *Spar Drusen* (F).

It is composed of the last-mentioned spar that has formed itself exteriorly into several planes or sides, wherefrom many different figures arise, the varieties of which have not yet been fully observed, nor can they be exactly described. The following are therefore mentioned, only as instances of the most regular and common kinds, viz.

(1.) Transparent; *Spatum drusicum diaphanum*.a. Hexagonal truncated, *Crytalli spatiosi hexagonii truncati*.

b. Pyramidal.

1. Dog's teeth; *Pyramidales distincti*. Found at Salberg, and in the iron mines at Dannemera in the province of Upland.2. Balls of crystallised spar, *Pyramidales concreti*.

These are balls which I have drufen, pyramidal, octaedral, spars accreted in their hollows or centres: they are found at Rettwin in the province of Dalarna, and other places (F).

F. Stalactitical spar; *Stalactites calcareus*. Stalactites, Stone-icicle, or Drop-stone.

This is formed from water saturated with lime, which, while running or dropping, deposits by degrees the calcareous earth which it has carried along with it from clefts of rocks, or from out of the earth. It is therefore commonly of a scaly, though sometimes of a solid and sparry texture. Its external figure depends on the place where it is formed, or the quantity of the matter contained in the water, and other like circumstances.

(1.) Scaled stalactites of very fine particles.

a. Of a globular form.

1. White, the pea-stone.

2. Grey, *pisolithus, oolithus*. Also the hammites, from its resemblance to the roes or spawn of fish. It has been exhibited by authors as petrified roes. The Ketton free-stone, of Rutlandshire, is a remarkable stone of this sort.

b. Hollow, in the form of a cone.

1. White, is found everywhere in vaults made with mortar, and through which water has had an opportunity to penetrate; and also in grottos dug in rocks of limestone.

c. Of an indeterminate figure. *Sinter*.

d. Of coherent hollow cones.

Of this kind is a stalactitical crust, which has formed a stratum, or rather filled a fissure between the strata of the earth, at Helsingborg in the province of Skone; it is of a very singular figure, resembling conical caps of paper placed and fixed one in the other, diminishing by degrees both in height and the other dimensions.

2. Solid

(E) The translator of Mr Cronstedt's treatise has adopted this German term *drufen* into the English language, for a cluster of regular-figured bodies, as a group conveys the idea of a cluster only, whether regular or of indeterminate figures.

(F) The name *spar* is very well known, and only used to determine a certain figure, viz. when a stone breaks into a rhomboidal, cubical, or a plated form, with smooth and polished surfaces, it is called *spar*: and as it is thus applied to stones of different kinds, without any regard to their principles, one ought necessarily to add some term to express the constituent parts at the same time that the figure is mentioned; for instance, calcareous spar, gypsum spar, flux spar, short or cockle spar, &c. This term, however, is applied only to earths, and such ores as are of the same figure as the lead spar, &c.

All crystallised spars, when broken, shew the sparry figure in their particles, and the crystallisation is to be ascribed to the empty space left by the contraction of the sparry principle: such holes filled with drufen of spars, are in Swedish called *drake*, or *drufe-hol*.

The figure of the crystals varies more in this genus than in any other, for which no reason can be assigned; it ought not to be ascribed to salts, as long as the presence of any such cannot be proved: but there are strong indications to suspect, that other substances may likewise have received the same property to assume an angular surface on certain occasions. See Mr Cronstedt's Introductory Speech at the Royal Academy of Sciences at Stockholm.

Besides, the consideration of those figures is a thing of more curiosity than of real use, because no miner has yet been able to make any conclusion relative to the quantity or quality of the ores, from the difference of the figures of spars found along with them; and the grotto-makers never take any notice of the angles or sides, but think it sufficient for their purpose if they make a fine or glittering appearance at a distance.

It would, nevertheless, be well if any one would take upon himself the trouble to observe whether each species of spar has not a certain determinate number of figures or sides, within which it is confined, in its accretions. This it has hitherto been impossible to do, because all species of spars have been confounded together, without regard to their different principles.

(2.) Solid stalactites of a sparry texture.

a. Hollow, and in form of a cone.

1. White, and semitransparent.

In making lime-water, one may observe how the lime gathers first like a pellicle on the surface of the water, and afterwards, when this breaks, falls down to the bottom in form of a scaly sediment, which is called *cremor calcis*: after that a new pellicle is formed, which likewise falls down; and in this manner it continues for a long while, although the lime-water had before been passed through a filter. This we may also imagine to be the way in which the works of nature are performed: whence the stalactites commonly is of a scaly texture, or at least discovers some tendency towards it. But a stalactites of a sparry texture, such as above-mentioned from Rouen, may be supposed to be owing to a more copious principle concurring at once: and in the same manner the sparry limestone and its crystallisations seem likewise to have been produced; since they, as far as we know, are only found in clefts, which, when they have been filled up with a stony matter, the Swedish miners call *klyfter*, and *gangar*, or *veins*. In regard to this, the stalactites, the sparry limestone, and also its crystallisations, might all be ranked under the same title in a systematical description, as very little different from one another, if it were not necessary, in describing mines and other works, to give them their separate names; because it is certain, that a piece which is broken from large spar-crystals, or from sparry stalactites, may in a cabinet pass extremely well for a common sparry limestone, without leaving any suspicion of its former figure before it was broke.

82 11. Saturated or united with the acid of vitriol. Gypsum, Plaster-stone, or Parget.

This is,

1. Looser and more friable than a pure calcareous earth.
2. Either crude or burnt, it does not excite any effervescence with acids; or, at most, it effervesces but in a very slight degree, and then only in proportion as it wants some of the vitriolic acid to complete the saturation.
3. It readily falls into a powder in the fire.
4. If burnt, without being red-hot, its powder readily concretes with water into a mass, which soon hardens; and then,
5. No heat is perceived in the operation.
6. It is nearly as difficult to be melted by itself as the limestone, and shews mostly the same effects with other bodies as the lime-stone: the acid of vitriol seems, however, to promote its vitrification.
7. When melted in the fire with borax, it puffs and bubbles very much, and for a long while, during the fusion, owing to the nature of both the salts.
8. When a small quantity of any gypsum is melted together with borax, the glass becomes colourless and transparent; but some sorts of alabaster and sparry gypsum, when melted in some quan-

tity with borax, yield a fine yellow transparent colour, resembling that of the best topazes. This phenomenon might probably happen with every one of the gypsiferous kind. But it is to be observed, that if too much of such gypsum is used in proportion to the borax, the glass becomes opaque, just as it happens with the pure limestone.

9. Burnt with a phlogiston, it smells of sulphur, and may as well by that means, as by both the alkaline salts, be decomposed; but for this purpose there ought to be five or six times as much weight of salt as of gypsum.

10. Being thus decomposed, the calc or earth which is left shows commonly some marks of iron.

The gypsiferous earth is found,

(1.) Loose and friable; *Terra gypsea pulverulenta*. Gypsiferous earth, properly so called; *Gubr.*

a. White.

(2.) Indurated,

A. Solid, or of no visible particles, Alabaster.

This stone is very easy to saw and cut, and takes a dull polish. It is not always found saturated with the acid of vitriol.

a. White, alabaster.

1. Clear and transparent.

2. Opaque.

b. Yellow.

1. Transparent, from the Eastern countries.

2. Opaque.

B. Gypsum of a scaled or granulated structure.

This is the common plaster-stone.

1. With coarse scales.

a. White.

2. With small scales. a. Yellowish. b. Greyish.

C. Fibrous gypsum, or plaster-stone, improperly (though commonly) called *English talc* by our druggists.

1. With the fibres coarse.

a. White, from Livonia.

2. With fine fibres.

a. White.

D. Spar-like gypsum. Selenites. This by some is also called *glacies maris*; and is confounded with the clear and transparent mica.

1. Pure selenites.

A. Transparent.

a. Colourless.

b. Yellowish.

2. Spar-like gypsum; *Marmor metallicum*.

This stone, on account of its heaviness, which comes near to that of tin or iron, is suspected to contain something metallic; but, as far as is hitherto known, no one has yet been able to extract any metal from it, except some traces of iron, which is no more than what all other gypsum contain.

A. Semitransparent; *spatum Bononiense*, the Bononian stone, or phosphorus. Its specific gravity is 4,5000: 1000.

b. Opaque.

a. White.

3. Liverstone, so called by the Swedes and Germans.

E. Chry-

E. Crystallised gypsum. Gypseous drusen; *drusee**gypseæ.*

(1.) Drusen of crystals of pure sparry gypsum.

a. Wedge-formed, are composed of a pure spar-like gypsum.

1. Clear and colourless. 2. Whitish yellow.

b. Capillary. a. Opaque, whitish yellow.

c. Of ponderous spar-like gypsum; *Marmor metallicum drusicum.*1. Jagged or like cocks combs, *cristati.*

These resemble cocks combs, and are found in clefts or fissures accreted on the surfaces of balls of the same substance.

2. White. 3. Reddish.

F. Stalactitical gypsum. *Gips sinte.*

This perhaps may be found of as many different figures as the calcareous stalactites, or sintes.

Mr Cronstedt has only seen the following, *viz.*1. Of no visible particles; in French, *grignard.*

a. Of an irregular figure.

a. Yellow.

b. White.

This is used in several works as alabaster, especially when it is found in large pieces; and then it commonly varies in colour between white and yellow, as also in transparency and opacity.

2. Of a spar-like texture.

a. In form of a cone.

a. White and yellow.

b. Of an irregular figure.

a. White.

Gypseous fossils abound in England. Plaster-stone, granulated and solid, some so very fine as to be alabaster, that is, take a surface and politure, are plenty in Derbyshire and Nottinghamshire, where are large pits of it, and also in most of the cliffs of the Severn, especially at the Old Passage in Somersetshire. A very fine semipellucid solid alabaster is found in Derbyshire. Fibrous tales, very fine, are found in the same pits of plaster-stone above-mentioned, and many other places. Selenites of many kinds abound in England in clays, inasmuch that it is needless to enumerate the places. Very fine gypseous drusen are found in Sheppy-isle; and some, perfectly pellucid as crystal, and large, have been dug from the salt-rocks at Nantwich in Cheshire. The *selenites rhomboidalis*, a rare fossil in other countries, is frequently found in England; but Shot-over-hill, in Oxfordshire, is famous for it. The isle of Sheppy affords a kind peculiar to that small spot of ground, and not found any where else in the world, fibrous, and always accreting in radiations like a star on the septaria, thence called *stella septarii*.

III. Calcareous earth satiated with the acid of common salt. *Sol ammoniacum fixum naturale.*

This is found,

1. In sea-water.

2. In salt-pits.

It is formed in great quantities at the bottoms of the salt-pans of the salt-works. It attracts the moisture of the air.

## IV. Calcareous earth united with the inflammable substance.

These have a very offensive smell, at least when they are rubbed, and receive their colour from the phlogiston, being dark or black in proportion as it predominates.

(1.) Calcareous earth mixed with phlogiston alone;

*Lapis sullus*, fetid stone and spar, or swine-stone and spar. Perhaps the smell of this stone may not be so disagreeable to every one: it goes soon off in the fire. Its varieties, in regard to the texture, are as follow:

A. Solid, or of no visible or distinct particles.

a. Black.

B. Grained.

a. Blackish brown.

C. Scaly, *particulis micaceis.*

1. With coarse scales.

a. Black.

2. With fine glittering or sparkling scales.

a. Brown.

D. Sparry.

a. Black.

b. Light brown.

c. Whitish yellow.

E. Crystallised.

1. In a globular form.

(2.) Calcareous earth united with phlogiston and the vitriolic acid. *Leberstein* of the Germans and Swedes. *Lapis hepaticus.*

This stone sometimes readily, at other times only when rubbed, smells like the *hepar sulphuris*, or gun-powder. It excites no effervescence with acids, and is a medium between the gypsum and the fetid stones (93), to which it has, however, generally been referred, although no lime can be made from it; whereas they are the fittest of all the different limestones to be burnt into lime. It is found,

A. Scaly.

1. With coarse scales.

a. Whitish yellow.

2. With fine glittering or sparkling scales.

a. Black.

The method that nature takes in combining those matters which compose the liver-stone, may perhaps be the same as when a limestone is laid in a heap of mundie while it is roasting; because there the sulphur unites itself with the limestone, whereby the limestone acquires that smell common to liver of sulphur, instead of which the vitriolic acid alone enters into the formation of gypsum. How the sulphur combines itself may likewise be observed in the slate-balls or kernels from Andrarum alum-mines, where it sometimes combines itself with a martial earth, with which this slate abounds, and forms therewith pyrites within the very slate-balls. The fetid or swine stones, and the liver-stone, are, in regard to the structure of their parts, subject to the same varieties as the other species of limestone: and it is to be observed, that a volatile alkali is commonly supposed to have entered into the composition of the fetid stones, though it has never yet been discovered by any experiment.

V. Calcareous earths blended with an argillaceous earth. *Marle, Marga.*

1. When crude, it makes an effervescence with acids; but,
2. Not after having been burnt; by which operation it is observed to harden, in proportion as the clay exceeds the calcareous substance.
3. It easily melts by itself into a glass, and even when it is mixed with the most refractory clay.
4. It is of great use in promoting the growth of vegetables, since the clay tempers the drying quality of the calcareous earth.
5. When burnt in a calcining heat, it readily attracts water: and, exposed to the air, in time it falls into a powder.

The varieties of this kind worthy to be taken notice of, depend on the different quantities of each of their component parts, and on the quality of the clay. We shall specify the following examples.

96 *A. Loose and compact, Marga friabilis.* This dissolves in water like common clay.

- a. Reddish brown.
- b. Pale red. This, when burnt, is of a yellowish colour, and used for making earthen-ware in some places.

97 *B. Semi-indurated, Marga indurata aëre fatescens.*

It is nearly as hard as stone when first dug up, but moulders in the open air. It is mostly flatty, and is not uncommon in the slate-rocks of Sweden, where it lies between the thick beds of flatty limestone, and is also found by itself forming very thick strata. It does not dissolve in water, till by a considerable length of time it has mouldered to a powder.

- a. Grey.
- b. Red.

98 *C. Indurated or stone marle.*

*A.* In loose pieces, *Marga indurata amorphæ*; by the Germans called *duckstein*, or *topfstein*.

- a. White.
- b. Grey.

It is formed from a sediment which the water carries along with it.

*n.* In continued strata. Hard flatty marle.

99 VI. Calcareous earth united with a metallic calx.

Here, as well as in the others, such a mixture or combination is to be understood, as cannot be discovered by the eye alone, without the help of some other means.

The subjects belonging to this division lose the property of raising an effervescence with acids, when they are rich in metal, or contain any vitriolic acid. However, there have been found some that contained 20 or 30 per cent. of metal, and yet have shewn their calcareous nature by the nitrous acid.

There are no more than three metals hitherto known to be united in this manner with the calcareous earth, *viz.*

100 (1.) Calcareous earth united with iron. White spar-like iron ore, *Minera ferri alba.* The *stahlstein* or *weiße eisenz* of the Germans.

1. This ore, however, is not always white, but commonly gives a white powder when rubbed.

2. It becomes black in the open air, as likewise in a calcining heat.

3. In this last circumstance it loses 30 or 40 per cent. of its weight, which by distillation has been found owing to the water that evaporates; and it is possible that some small quantity of vitriolic acid may, at the same time, evaporate with the water.

4. It is of all the iron ores the most easy to melt, and is very corrosive when melted.

This kind is found,

*A.* Loose; the mouldered part of the indurated fort.

a. Black, like foot.

b. Dark brown, somewhat resembling umbre.

*B.* Indurated.

1. Solid, of no distinct particles.

a. Red. Looks like red ochre, or the red hæmatites, but dissolves in the acid of nitre with a great effervescence.

2. Scaly, *particulis micacis.*

a. White. b. Blackish grey.

3. Spar-like.

a. Light brown.

4. Drusen.

a. Blackish brown. b. White.

1. Porous. This is often called *eisen- white*, or *flöz ferri.*

2. Cellular.

(2.) Calcareous earth united with copper.

*A.* Loose and friable. Mountain blue. Germanicé, *Bergblau.*

This dissolves in aquafortis with effervescence.

*B.* Indurated.

1. Pure calcareous earth mixed with calx of copper. Armenian stone, *lapis Armenus.*

Such, according to the description of authors, ought the nature of the stone called *lapis Armenus* to be, though the druggists substitute in its stead a pale blue lapis lazuli, free from marcasite.

2. Gypseous earth united with calx of copper.

Is of a green colour; and might perhaps be called *turquoise ore*, or *malachites*; though we do not know if all sorts of turquoise ore are of this nature.

a. Semi-transparent; is found at Ardal in Norway. By chemistry we know, that alkaline salts produce a blue colour with copper, which is changed into green as soon as any acid is added; and from thence the reason is obvious why a green colour may be found among calcareous copper ores, *viz.* when the vitriolic acid is in the neighbourhood of it.

(3.) Calcareous earth united with the calx of lead.

This is a lead ochre, or a spar-like lead ore, which, in its formation, has been mixed with a calcareous earth, and for that reason effervesces with acids.

*A.* Loose and friable.

a. White, from Krifersberget at Nya Kopparberget in Westmanland.

*B.* Indurated.

1. Scaly.



## a. Yellowish.

Both these varieties contain a considerable quantity of lead, viz. 40 per cent. more or less; and the calcareous earth is as equally and intimately mixed with it, as in the white iron ore. Thus may these be distinguished from other lead-ochres and spar-like lead ores, which are much richer in lead, and never effervesce with acids. These last mentioned also seem to be produced by nature, nearly as the spar-like lead ores, and as the *flaves saturni* are formed in calcining a regulé of lead.

## THE SECOND ORDER.

105

## THE Siliceous kind.

This siliceous earth is, of all others, the most difficult to describe and to distinguish perfectly: however, it may be known by the following characters, which are common to all bodies belonging to this order.

1. In its indurated state it is hard, if not in regard to the whole, yet at least in regard to each particle of it, in a degree sufficient to strike fire with steel, and to scratch it, when rubbed against it, though the steel be ever so well tempered.
2. When pure, and free from heterogeneous particles, it does not melt by itself, neither in a reverberatory, nor in a blast furnace.
3. After being burnt, it does not fall to a powder, neither in the open air, nor in water, as the calcareous order does, but becomes only a little looser and more cracked by the fire, unless it has been very slowly and by degrees heated.
4. It excites no effervescence with acids.
5. In the fire it melts easiest of all to a glass with the fixed alkaline salt; and hence it has got the name of *vitrescent*, though this name is, properly speaking, less applicable to this order than to a great many other earths.

The mineral bodies that are comprehended in this order, are, indeed, somewhat different from one another. This difference, however, on first sight may be discerned: but, in regard to their effects in the fire, and other chemical experiments, it cannot be esteemed of any great consequence, at least while we are no farther advanced in the art of decomposing these hard bodies, and as long as no one has thought it worth the trouble and expence to use those means which are already discovered for this purpose; namely, the burning-glass or concave mirror; and to continue such experiments which Mr Pott has ingeniously begun as a basis for his *Lithogæognosia*. For want of this, there is no other way left, than to consider these bodies as simple substances, (how much soever compounded they may be), in the following manner.

I. Diamond. *Adamas gemma*.

Which,

1. Of all stones, is the hardest.
2. Is commonly clear, or transparent; which quality, however, may, perhaps, only belong to its crystals, but not to the rock itself from which they have their origin.
2. Its specific gravity is nearest 3,500. When brought to Europe in its rough state, it is in

106

form either of round pebbles with shining surfaces, or of crystals of an octoëdral form.

## a. Colourless, or diaphanous, or the diamond properly so called.

But it also retains this name when it is tinged somewhat red or yellow. Being rubbed, it discovers some electrical qualities, and attracts the mastic.

b. Red; Ruby. *Adamas ruber*; *Rubinus*.— 107

Which, by lapidaries and jewellers, is, in regard to the colour, divided into,

1. The ruby of a deep red colour inclining a little to purple.
2. Spinell, of a dark colour.
3. The balais, pale red, inclining to violet. This is supposed to be the mother of the rubies.
4. The rubicell, reddish yellow.

However, all authors do not agree in the characters of these stones.

II. Sapphire. *Sapphyrus gemma*. 108

It is transparent, of a blue colour; and is said to be in hardness next to the ruby, or diamond.

Sapphires are said to be found in Alsatia, at St Amarin: but accounts of this kind are in general not to be depended upon, as the fluors are frequently met with in collections and the druggists shops under the name of *sapphires*, when they are of a deep blue colour; not to mention that the quartz is always termed a precious stone, whenever it is found clear and of a fine colour. The sapphire is said to lose its blue colour in the fire. Those which are but a little tinged are called *white sapphires*. The sapphire is seldom found of a very deep blue colour, and free from parallel flaws which run through it.

III. Topaz. *Topazius gemma*. 109

This is a precious stone which, when rough and perfect, is sold in a crystallised form. At Schneckenstein in Saxony, these crystals are found of a prismatic octoëdral form, with no points, but flat, and with some facets at the top; however, without doubt the oriental topazes have another figure.

Experiments by fire have been made on the Schneckenstein topazes by Mr Pott, as may be seen in his *Lithogæognosia*.

To this kind may be referred,

- a. The pale yellow topaz; which is nearly uncoloured, and is found at Schneckenstein.
- b. The yellow topaz, from Schneckenstein.
- c. Deep yellow, or gold-coloured topaz, or oriental topaz.
- d. Orange-coloured topaz.
- e. The yellowish green topaz, or *chrysolite*.

It is of a grass-green colour, and may perhaps belong to some other species, which might be discovered, if it could be obtained rough, or in its matrix, and large enough or in such quantity as is necessary for experiments to be made.

f. The yellowish green and cloudy topaz, the *chrysoloprase*.

This is perhaps the substance which serves as a matrix to the chrysolite: for those which have been seen of this kind are like the clear-veined,

called in Swedish *milk-crystal*, and *quartz*, which is of the first degree of crystallisation.

g. Bluish green topaz, or the beryl.

This varies in its colours; and is called, when,

1. Of a sea-green colour, the *aqua-marina*;
2. When more green, the *beryl*.

They are found in the stream-works in Saxony and Bohemia, in form of pebbles, or round pieces.

110 IV. Emerald. *Smaragdus gemma*.

Its chief colour is green, and is transparent. It is the softest of precious stones, and when heated it is phosphorescent like the fluors. What in some cabinets is given out for its matrix, and said to come from Egypt, is nothing else than a deep green cockle-spar; of which colour we likewise find cockle, or shirl, in the island of Uto near Stockholm, and at Norbery in the province of Westmanland in Sweden.

Mr Maillet informs us, that in former times the best emeralds were found in Egypt.

111

To the precious stones belong also the jacinths, or hyacinths; which are crystals harder than quartz crystals, transparent, of a fine reddish-yellow colour when in their full lustre, and formed in prisms pointed at both ends: these points are always regular, in regard to the number of the facets, being four on each point; but the facets seldom tally: the sides also which form the main body, or column, are very uncertain in regard both to their number and shape; for they are found of four, five, six, seven, and sometimes of eight, sides: further, the column or prism is in some also so compressed, as almost to resemble the face of a spherical faceted garnet. These crystals lose their colour, become white, and do not melt in the fire; by which qualities chiefly they may be distinguished from garnets, which are likewise sometimes found of a colour not inferior to the true jacinths. The author had not, at the time when he wrote this essay, seen the true jacinths; but says that the reddish yellow garnets from Greenland are sold by the jewellers for jacinths; so are likewise the East Indian garnets of the same colour; and, what is still more, there are some jewellers that do not know the true distinctions between a jacinth and a garnet at all, but buy and sell the garnets for jacinths, when they are of a fine reddish yellow colour; this must in particular be owing to the scarcity of the true jacinth.

Mr Cronstedt says he lately got some jacinths of a quadrangular figure, which did not melt in the fire, but only became colourless.

112

V. Quartz. *Quartzum*.

This stone is very common in Europe, and easier to be known than described. It is distinguished from the other kinds of the siliceous order, by the following qualities.

1. That it is most generally cracked throughout, even in the rock itself; whereby,
2. As well as by its nature, it breaks irregularly, and into sharp fragments.
3. That it cannot easily be made red-hot, without cracking still more.

4. It never decays in the air.

5. Melted with pot-ashes, it gives a more solid and fixed glass than any other of the siliceous order.

6. When there has been no interruption in its natural accretion, its substance always crystallises into hexagonal prisms pointed at one or both ends.

7. It occurs in clefts, fissures, and small veins in rocks. It very seldom forms large veins, and still seldom whole mountains, without being mixed with heterogeneous substances.

The quartz is found,

(1.) Pure.

A. Solid, of no visible particles with a glossy surface. Fat quartz.

a. Uncoloured and clear, *diaphanum*. This has no crystallised form, but is nevertheless as clear as quartz crystals of the best water.

b. White, the common fat quartz.

c. Blue.

d. Violet.

B. Grained.

a. White.

b. Pale green.

C. Sparry quartz.

This is the scarcest; and ought not to be confounded with the white felt-spar, being of a smoother appearance, and breaking into larger and more irregular planes.

a. Whitish yellow. b. White.

D. Crystallised quartz. Rock crystal. Quartz crystal.

Its figure is already described; and, in regard to the colours, the following varieties occur.

1. Opaque, or semi-transparent.

a. White, or of a milk colour.

b. Red, or of a carnelian colour.

c. Black.

2. Clear.

a. Blackish brown, smoky topaz, or *raunch topaz* of the Germans.

b. Yellow; found in Bohemia, and sold instead of topazes.

c. Violet; the amethyst.

d. Uncoloured; rock-crystal, properly so called. When these coloured crystals are not clear, they are called *fusus*; for instance, *topaz-fusus*, *amethyst-fusus*, &c.

(2.) Impure quartz.

A. Mixed with iron, in form of a black calx.

This is of a glossy texture, and contains a great quantity of iron.

B. Mixed with copper in form of a red calx.

a. Red.

VI. The flint. *Silex pyromachus*, *Lapis corneus*, or *hornstein* of the Germans. 113

This is equally common with the quartz, and it is full as difficult to describe it; especially as it forms a kind of intermediate substance between quartz and jasper, both which it so nearly resembles, that it is not easy to point out such characters as shall readily distinguish it from them. The best way, perhaps, will be to speak of its properties

erties comparatively; and then we may say, that,

1. It is more uniformly solid, and not so much cracked in the mass as the quartz; and,
2. It is more pellucid than the jasper.
3. It bears being exposed to the air, without decaying, better than the jasper, but not so well as the quartz.
4. It is better for making of glass than the jasper, but is not quite so good as quartz for that purpose.
5. Whenever there has been an opportunity in this matter of its shooting into crystals, quartz crystals are always found in it; just as if the quartz had made one of its constituent parts, and had on certain circumstances been squeezed out of it; this is to be seen in every hollow flint, and its clefts, which are always filled up with quartz.
6. It often shows most evident marks of having been originally in a soft and slimy state.

The several varieties of this species have obtained distinct names, more with respect to their colours than from any real difference in their substance; but these are still necessary to be retained, as the only names used by jewellers and others, who know how to value them accordingly.

114

- (1.) The opal. *Opalus paderota*.

It is the most beautiful of all the flint kind, owing to the changeable appearance of its colours by reflection and refraction, and must therefore be described under both these circumstances.

- a. The opal of Nonnius, the sagenon of the Indians.

This appears olive-coloured by reflection, and seems then to be opaque; but when held against the light, is found transparent, and of a fine ruby red.

That opal is supposed to have been of this kind, which Pliny mentions in his Natural History, chap. 307. sect. 21. and which he says was in the senator Nonnius's possession, who rather suffered banishment than part with it to Antony.

This stone was at that time valued in Rome at 20,000 sesterces. But the stone here particularly described, was found in the ruins of Alexandria; it is about the size of a hazle-nut, and was bought for a trifle of a French druggist, named *Roboly*, and presented to the French general consul Lironcourt, who afterwards offered it to sale in several places for the sum of 40,000 rixdollars. See Haffelquist's Travels to the East, under the article of OPAL.

This very stone was in the year 1763 in the possession of his excellency the duke de Nivernois, then ambassador to the British court.

There is, however, another of the same kind in Sweden, which by reflection appears rather brown; but by refraction is red, with violet veins.

- b. The white opal. Its ground is white, of a glass-like complexion, from whence are thrown out green, yellow, and bluish rays; but it is of a reddish or rather flame colour, when held

against the light.

1. Of many colours. The oriental opal.
  2. Of a milky colour.
  3. Bluish, and semi-transparent. This is not so much valued as those which are more opaque, because it is easier to be imitated by art.
- (2.) The cat's eye. *Pseudopalus*. 115
- This stone is opaque, and reflects green and yellowish rays from its surface, and is found in Siberia.
- (3.) The onyx. *Onyx camebaja*. Memphites. 116
- This stone is the hardest of the flinty tribe; and consists of differently coloured veins, which run parallel to one another, sometimes in straight, sometimes in curved lines. It is found of two sorts.
- a. Nail-coloured onyx, having pale flesh-coloured and white lines. From the river Tomm in Siberia.
- b. With black and white lines. The oriental onyx.
- The old Romans were accustomed to cut figures in relief on the straight-lined onyxes, which they called *camebaja*; these are still counterfeited, and called *camayeu*. Those which consist of concentric circles were called *memphites*; and we have now of this kind cut to be set in rings, under the name of *occhi di gatti*, which, however, ought not to be confounded with the pseudopal, or cat's eye.
- (4.) The chalcedony, or white agate. 117
- Is a flint of a white colour, like milk diluted with water, more or less opaque; it has veins, circles, and round spots. It is said to be softer than the onyx, but much harder than those agates which are sometimes found of the same colour.
- a. The white opaque chalcedony, or *cacholong*, from the Buckharish Calmucks. This was first made known by one Renz, a Swedish officer, who for several years had been in that country. The inhabitants find this flint on the banks of their rivers, and work idols and domestic vessels out of it.
- b. Of white and semi-transparent strata; from Ceylon.
- c. Bluish grey; from Ceylon and Siberia.

- (5.) The carnelian. *Carniolus*. 118
- Is of a brownish red colour, and often entirely brown. Its name is originally derived from its resemblance to flesh, or to water mixed with blood.
- a. Red.
- b. Yellowish brown, looks like yellow amber, from the river Tomm in Siberia. It is said not to be so hard as the chalcedony.

- (6.) The fardonyx. 119
- Is a mixture of the chalcedony and carnelian, sometimes stratum-wife, and sometimes confusedly blended and mixed together.

- a. Striped with white and red strata: this serves as well cut in cameo as the onyx.
- b. White, with red dendritical figures. This very much resembles that agate which is called the *mocha stone*, but with this difference, that the figures are of a red colour in this, instead of black, as in that agate.

Between the onyx, carnelian, chalcedony, fardonyx, and agate, there seems to be no real difference,

difference, except some inexplicable degrees of hardness.

(7.) The agate; *Achates*.

This name is given to flints that are variegated with different colours, promiscuously blended together; and they are esteemed in proportion to their mixture of colours, their beauty, and elegance. Hence also they have obtained variety of names, mostly Greek, as if the business of the lapidary in cutting of them, and admiring their several beauties and figures, had been derived from that nation alone.

- a. Brown opaque agate, with black veins, and dendritical figures; the Egyptian pebble.
- b. Of a chalcedony colour, *achates chalcedonians*.
- c. Semi-transparent, with lines of a blackish brown colour, and dendritical figures; the mocha stone. This is much esteemed, and makes a valuable part of some collections, where it has a place chiefly for the sake of its figures, resembling vegetables, animals, &c. which however are often improved by art.
- d. Semi-transparent, with red dots; *Gemma divi Stephani*. When the points are very minute, so as to give the stone a red appearance, it is by some called *Sardea*.
- e. Semi-transparent, with clouds of an orange colour.
- f. Deep red or violet, and semi-transparent.
- g. Of many colours, or variegated.
- h. Black.

VII. Jasper. *Jaspis*.

All the opaque flints are called by this name, whose texture resembles dry clay, and which have no other known quality, whereby they may be distinguished from other flints, except that they may be more easily melted in the fire; and this quality perhaps may proceed from some heterogeneous mixture, probably of iron.

- (1.) Pure jasper; which by no means yet known can be decomposed.
  - a. Green with red specks or dots; the *heliotrope*, or blood-stone. b. Green. c. Red.
  - d. Yellow. e. Red with yellow spots and veins. f. Black.
- (2.) Jasper containing iron; *Jaspis martialis*, *Sinople*.
  - A. Coarse-grained.
    - a. Red and reddish brown; *sinople*.
  - B. Steel-grained, or fine-grained.
    - a. Reddish brown: looks like the red ochre or chalk used for drawing; and has partition veins, which are unctuous to the touch, like a fine clay, and other like kinds.
  - C. Of a solid and shining texture, like a slag.
    - a. Liver-coloured; and, b. Deep red. c. Yellow. This last mentioned, when calcined, is attracted by the loadstone; and being effayed, yields 12 to 15 per cent. of iron.

VIII. Rhombic quartz; *Spatum scintillans*, *Feltpatum*.

This has its name from its figure, but seems to be of the same substance as the jasper. We have not, however, ranked them together, for want of true marks to distinguish the different sorts of the stony tribe from one another.

This kind is found,

- i. Sparry.
  - a. White.
  - b. Reddish brown.
  - c. Pale yellow.
  - d. Greenish.

This last mentioned resembles very much the schorl or cockle-spar; but is neither so easy to melt in the fire, nor of so exact a figure.

2. Chrytallified.
  - a. In separate or distinct rhomboidal crystals.

## THE THIRD ORDER.

THE Garnet kind. *Terra granatee*.

The matter composing the substance of garnet, and schorl or cockle, except that small portion which is metallic, does in its indurated state resemble the siliceous tribe, so far as relates to external appearance and hardness; and therefore we would willingly have followed the opinion commonly received, of considering these two substances as arising from one another, if we had not been persuaded to the contrary by the following qualities of the garnet.

1. It is more fusible, in proportion as it contains less metallic matter, and is more transparent or glassy in its texture; which is quite contrary to the siliceous kind.
2. This is the reason, perhaps, why the garnet, mixed with the salt of kelp, may on a piece of charcoal be converted to a glass by the blow-pipe, which cannot be done with the flints; and,
3. Why the most transparent garnet may, without any addition, be brought to a black opaque slag by the same means.
4. It is never, so far as is hitherto known, found pure, or without some mixture of metal; and especially iron, which may be extracted by the common methods.
5. The garnet matter, during the crystallisation, has either been formed in small detached quantities, or else has had the power of shooting into crystals, though closely confined in different substances: since garnets are generally found dispersed in other solid stones, and oftentimes in the harder ones, such as quartz and chert.

I. Garnet; *Granatus*. Which is a heavy and hard kind of stone, crystallising in form of polygonal balls, and is mostly of a red, or reddish brown colour.

A. garnet mixed with iron; *Granatus martialis*.

1. Coarse-grained garnet-stones, without any particular figure; in Swedisch called *Granatberg*; in German, *Granatstein*. a. Reddish-brown garnet. b. Whitish-yellow. c. Pale yellow.
2. Crystallised garnet.
  - a. Black. b. Red: semi-transparent, and cracked; transparent. c. Reddish yellow transparent; the jacinth, or hyacinth.
  - d. Reddish brown. e. Green. f. Yellowish green.

B. Garnet mixed with iron and tin.

1. Coarse grained, without any particular figure.
  - a. Blackish-brown.

2. Chrytall-

## 2. Crystallised.

a. Blackish-brown.

b. Light-green or white.

The *bergs-radets*, or mine-masters, Mr Brandt and Mr Rinman, have published some experiments on this kind of garnet, in the Memoirs of the Royal Academy of Sciences at Stockholm.

## C. Garnet mixed with iron and lead.

## 1. Crystallised.

a. A reddish-brown, discovered and accurately examined by the *bergs-radet* Mr Von Swab (g).

125 II. Cockle, or shirl. *Bafaltes*; *Cornuus crystallifatus Wallerii*; *Stannum crystallis columnaribus nigris Linnæi*.—Is a heavy and hard kind of stone, which shoots into crystals of a prismatic figure, and whose chief colours are black or green. Its specific gravity is the same as the garnets, viz. between 3000 and 3400, though always proportionable to their different solidity.

126 A. Cockle, or shirl, mixed with iron.

## 1. Coarse, without any determined figure.

a. Green, found in most of the Swedish iron mines.

## 2. Sparry.

a. Deep green, (the mother of the emeralds), from Egypt.

b. Pale green.

c. White.

This occurs very frequently in the scaly limestones; and its colour changes from deep green to white, in proportion as it contains more or less of iron.

128 3. Fibrous, striated cockle, or shirl: it looks like fibres or threads made of glass.

## A. Of parallel fibres.

a. Black.

b. Green.

c. White.

B. Of concentrated fibres. The barred cockle, or shirl, from its fibres being laid stellarwise.

a. Blackish green, from Salberg, in Westmanland; where, being found together with a steel-grained lead ore, the whole is called *grau-ris-malm*, or pine-ore, from its resemblance to the branches of that tree. This kind of cockle is also found at Uto in Malaren.

b. Light green.

c. White.

129 4. Crystallised cockle, or shirl.

a. Black.

To this species of cockle, or shirl, belong most of those substances called *imperfect asbestos*; and as the cockle perfectly resembles a slag from an iron furnace, both in regard to its metallic contents and its glassy texture, it is no wonder that it is not soft enough

to be taken for an asbestos. It has, however, only for the sake of its structure, been ranked among the asbestos. The striated cockle, or shirl, compared to the asbestos, is of a shining and angular surface (though this sometimes requires the aid of the magnifying-glass to be discovered), always somewhat transparent, and is pretty easily brought to a glass with the blow-pipe, without being consumed as the pure asbestos seem to be.

b. Deep green, from Salberg in Westmanland.

c. Light green, from Enighets-grufvan at Norberg in Westmanland.

d. Reddish brown; from Sorwik at Grogne in Westmanland, and Glaushammar in the province of Nerike.

The tauffstein, from Basl, is of this colour, and consists of two hexagonal crystals of cockle grown together in form of a cross: this the Roman Catholics wear as an amulet, and is called in Latin *lapis crucifer*, or the cross-stone.

It is not impossible that there may be some kinds of cockles, or shirls, which, besides iron, also contain tin or lead, as the garnets: it has been said, that lead has been melted out of a cockle, from Rodbeck's Eng at Umea in Lapland; and it seems likewise very probable that the cockles which are found in the English tin-mines may contain some tin. There are some crystals of cockle found which are fusible to a greater degree than any sort of stone whatsoever: these are always of a glassy texture, and semi-transparent.

The figure of the cockle crystals is uncertain, but always prismatic: the cockle from Yxfo at Nya Kopparberg, is quadrangular; the French kind has nine sides, or planes; and the tauffstein is hexagonal.

The name *cockle* for these substances is an old Cornish mineral name; but is also given sometimes to other very different matters.

We have not in England any great quantity of species of cockles; the chief are found in the tin mines of Cornwall, and some fine crystallised kinds have been brought from Scotland.

The English mineral name of *call*, has been used by some authors as synonymous with *cockles*, and they are confounded together at the mines; but the call, definitely speaking, is the substance called *wolfram* by the Germans, &c.

Garnets, though small, are often found in micaceous stones in England; but extreme good garnets are found in great plenty also in like stones in Scotland.

## THE FOURTH ORDER.

## The Argillaceous kind.

The principal character whereby those may be distinguished from other earths is, that they harden in the fire, and are compounded of very minute particles, by which they acquire a dead or dull appearance when broken.

## I. Porcelain

(e) When any of the garnet kind is to be tried for its containing metal, the iron ought to be melted out of it by the common process; and if the garnet, at the same time, contains both tin and lead, these two metals are likewise included in the iron: however, they may be extracted out of the iron, by exposing it to a heat augmented by degrees; because then the tin and lead sweat out in form of drops, almost pure, though always somewhat mixed with iron.

Argillaceous  
EARTH.I. Porcelain clay; *Terra porcellanea*, vulgò *Argilla*  
*appra*.and without much labour, a fine polish. It is  
found, *Argillaceous*  
EARTH.

131

This is very refractory in the fire, and cannot in any common strong fire be brought into fusion any farther than to acquire a tenacious softness, without losing its form: it becomes then of a dim shining appearance and solid texture, when it is broke; strikes fire with steel; and has consequently the best qualities required as a substance whereof vessels capable of resisting a melting and boiling heat, and of holding salts and acids, can be made. It is found,

132

(1.) Pure, *Pura*.*A* Diffusible in water.

1. Coherent and dry.

*a* White. Mr Cronstedt affirms that he has seen a root of a tree changed into this clay.

2. Friable and dry.

*a* White.

These may be called *pure*, since, after being burnt, they are quite white, though they have been exposed to a quick melting heat; and it may be queried, if all such clays must not be somewhat harsh, or at least not unctuous to the touch.

133

(2.) Mixed with phlogiston, and a very small quantity of inseparable heterogeneous substances.

Of these are,

*A* Diffusible in water.*a* White and fat pipe-clay.*b* Of a pearl colour.*c* Bluish grey.*d* Grey.*e* Black.*f* Violet.

These contain a phlogiston which is discovered by exposing them to quick and strong fire, in which they become quite black interiorly, assuming the appearance of the common slints, not only in regard to colour, but also in regard to hardness: but if heated by degrees, they are first white, and afterwards of a pearl colour. The fatter they seem to be, which may be judged both by their feeling smooth and unctuous, and by their shining when scraped with the nail, they contain a larger quantity of the inflammable principle. It is difficult to determine, whether this strongly inherent phlogiston be the cause of the above-mentioned pearl colour, or prevents them from being burnt white in a strong fire: yet no heterogeneous substance can be extracted from them, except sand, which may be separated from some by means of water, but which sand does not form any of the constituent parts of the clays. If they be boiled in aqua regis in order to extract any iron, they are found to lose their viscosity.

134

*B* Indurated.

Is commonly unctuous to the touch, and more or less difficult to be cut or turned in proportion to its different degrees of hardness; is not diffusible in water; grows hard, and is very refractory in the fire; pounded and mixed with water, it will not easily cohere in a paste: however, if it is managed with care, it may be baked in the fire to a mass, which, being broke, shews a dull and porous texture. It takes for the most part,

*a*. Compact and soft; *Smectis*, Briançon or French chalk. 135

*a*. White.*b*. Yellow.*c*. Red and white, and which looks like Castile soap.

*b*. Solid and compact steatites, and also soap-rock. 136

*a*. White or light green. *b*. Deep green*c*. Yellow.

It is a very difficult matter to specify all the varieties of the soap-stones in regard to their hardness or softness, since they cannot be compared with any standard measure. Those from Risver, Sikkisberg, and China, are a great deal harder and more solid than the English kind from the Land's End, which breaks between the fingers; but are soft in comparison to that from Salberg, which is there called *serpentine*, although both these varieties may in discriminately be made use of for cutting and turning. The soft ones, however, are not so apt to crack, when they are worked, as the harder. But none of these varieties is found in the rock, without being interperseed with the unctuous clefts. When they are too many, too close to one another, and make the stone unfit for use, they are in this case called by the Swedish miners, *Skjolige*; and of this kind is a great quantity found at Salberg and Swartwik. Most part of the soap-rock which is found in Sweden, is likewise mixed with glimmer or mica; and then it is called *telgsten*, that is, *ollaris*.

*c*. Solid, and of visible particles; serpentine stone. 137

1. Of fibrous and coherent particles. This is composed, as it were, of fibres; and might therefore be confounded with the asbestos, if its fibres did not cohere so closely with one another as not to be seen when the stone is cut and polished. The fibres themselves are large, and seem as if they were twisted.

*a*. Deep green. This is sold for the *lapis nephriticus*, and is dug at some unknown place in Germany.

*b*. Light green from Skienhyttan, in Weltmanland; in Sweden it is used by the plate-smiths instead of the French chalk.

2. Fine-grained serpentine stone: the Zoeblietz serpentine. 138

*a*. Black. *b*. Deep green. *c*. Light green, *d*. Red. *e*. Bluish grey. *f*. White. These colours are all mixed together in the serpentine stone from Zoeblietz, but the green is the most predominant colour.

(3.) Mixed with iron. This is, 148

*A* Diffusible in water.

*a*. Red. Some of the bricks which are imported

ported from certain places in Germany, seem to be made of this kind.

## B. Indurated.

1. Martial soap-earth; *Creta Brianzonica martialis*.
  - a. Red, and mixed with some calcareous matter.
2. Martial soap-rock; *Steatites martialis*.
  - a. Black. b. Red.

140 III. Stone-marrow; *Lithomarga*. *Keffekil* of the Tartars.

1. When dry, it is as fat and slippery as soap; but,
2. Is not wholly diffusible in water, in which it only falls to pieces, either in larger bits, or resembles a curd like mass.
3. In the fire it easily melts to a white or reddish frothy slag, consequently is of a larger volume than the clay was before being fused.
4. It breaks into irregular scaly pieces.
  - A. Of coarse particles: Coarse stone-marrow.
    - a. Grey, from Ofmundberget, in the parish of Rettwik, in Dalarne; and is there called *walklera*, that is, fuller's earth. It is mentioned in an account of Ofmundberget, published in the Transactions of the Academy of Sciences at Stockholm, in the year 1739, by the berg's-radet, or mine-master, Mr Tilas.
    - b. Whitish yellow, from the Crim Tartary, where it is called *keffekil*, and is said to be used for washing instead of soap.
  - B. Of very fine particles; fine stone-marrow.
    - a. Yellowish-brown; *Terra Lemnia*.—Is of a shining texture, falls to pieces in the water with a crackling noise; it is more indurated than the preceding, but has otherwise the same qualities.

## 141 III. Bole.

Is a fine and dense clay of various colours, containing a great quantity of iron, which makes it impossible to know the natural and specific qualities of the bole itself, by any easy method hitherto in use. It is not easily softened in water, contrary to what the porcelain and the common clays are, (I. & V.); but either falls to pieces in form of small grains, or repels the water, and cannot be made ductile. In the fire it grows black, and is then attracted by the loadstone.

## 142 A. Loofe and friable boles, or those which fall to a powder in water.

- a. Flesh-coloured bole.
- b. Red.
  1. Fine; *Bolus Armenus*.
  2. Coarse; *Bolus communis officinalis*.
  3. Hard; *Terra rubrica*.
- c. Green; *Terre verte*.
  1. Fine.
  2. Coarse.
- d. Bluish-grey, is ductile as long as it is in the rock, but even then repels the water; it contains 40 per cent. of iron; which metal being melted out of it in a close vessel, the iron crystallises on its surface.

## e. Grey.

1. Crystallised in a spherical polygonal figure.
2. Of an undeterminate figure.
 

At the time when the *terre sigillate*, or sealed earths, were in general use, the druggists endeavoured to have them of all colours, and for that reason they took all sorts of clays, and sealed them: not only the natural ones, but likewise such as had been coloured by art, or had been mixed with *magnesia alba officinalis*, or other things, were afterwards vended for true boles; and for this reason the species of boles is still thought to comprehend so many varieties. Thus the Cologne clay is by the druggists ranked among the white sealed earths, and is called a *white bole*: and this same clay is by the Swedish potters called *Englefsk jord*, or English earth; and by the tobacco-pipe makers *pip-lera*, or pipe-clay, &c.: which shews how great a confusion there must ensue, if the knowledge of these bodies was not founded upon a surer ground than the colour, figure, and names invented by common mechanics. Since the most part of these *terre sigillate*, or sealed earths, are found to contain iron, we may conclude that the bole must be a martial clay; and, as such, it seems to be more fit for medical uses than other clays, if any dead earth must be used internally, when there is such an abundance of finer substances.

## B. Indurated bole.

## A. Of no visible particles.

This occurs very often in form of slate, or layers, in the earth; and then is made use of as an iron ore. However, it has usually been considered more in regard to its texture than to its constituent parts; and has been called *slate*, in common with several other earths which are found to have the same texture.

- a. Reddish-brown; in most collieries, between the seams of coal.
  - b. Grey; from Coalbrookdale in Shropshire, and most collieries of England.
- 144 B. Of scaly particles.—The hornblende of the Swedes.

Is distinguished from the martial glimmer, or mica, by the scales being less shining, thicker, and rectangular.

- a. Black.—This, when rubbed fine, gives a green powder.
- b. Greenish.

Both these, particularly the black, are found every-where in Sweden among the iron-ores, and in the Grunsten. The hornblende grows hard in the fire, which is the reason why it is ranked here among the clays, though in all its other qualities it much resembles the cockle or shirl.

IV. Tripoli. *Terra Tripolitana*.

Is known by its quality of rubbing hard bodies, and making their surfaces to shine; the particles of the tripoli being so fine as to leave even no scratches on the surface. This effect

effect, which is called *polishing*, may likewise be effected by other fine clays when they have been burnt a little. The tripoli grows somewhat harder in the fire, and is very refractory: it is with difficulty dissolved by borax, and still with greater difficulty by the microcosmic salt. It becomes white when it is heated: when crude, it imbibes water, but is not diffusible in it: it tastes like common chalk, and is rough or sandy between the teeth, although no sand can by any means be separated from it. It has no quality common with any other kind of earth, by which it might be considered as a variety of any other. That which is here described is of a yellow colour, and is sold by druggists. This kind of tripoli has been lately discovered in Scotland. But the *rotten-stone*, so called, is another sort found in England, viz. in Derbyshire. It is in common use in England among workmen for all sorts of finer grinding and polishing, and is also sometimes used by lapidaries for cutting of stones, &c.

146 V. Common clay, or brick clay. *Argilla communis; vulgaris plastica.*

This kind may be distinguished from the other clays, by the following qualities.

1. In the fire it acquires a red colour, more or less deep.
2. It melts pretty easily into a greenish glass.
3. It contains a small quantity of iron and of the vitriolic acid, by which the preceding effects are produced.

It is found,

A. Diffusible in water.

1. Pure.

- a. Red clay.
- b. Flesh-coloured, or pale-red.
- c. Grey.
- d. Blue.

e. White, is found in the woody parts of Sodermanland, Dalarna, and of other provinces. It is often found in a slaty form, with fine sand between its strata. It is not easy to be baked in the fire: when it is burnt, it is of a pale-red colour, and is more fusible than the preceding ones.

f. Fermenting clay. *Argilla intumescens.*

This is very like the preceding, as to the external appearance and other qualities; but when they are both found in the same place, which is not uncommon in several of our mine countries, they seem to be different in regard to the fermenting quality of this variety. This fermentation cannot be the effect of the sand mixed with it, because sand is found in them both: and besides, this kind ferments in the same manner when it is mixed with gravel or stones; and then it ferments later in the spring than the other, since by the stones, perhaps, the frost is longer retained in it.

2. Mixed with lime. See MARLE, n° 95.

B. Indurated.

1. Pure.

a. Grey slaty.

b. Red slaty, from Kinnekulle, in the province of Westergotland.

2. Mixed with phlogiton, and a great deal of the vitriolic acid. See ALUM Ores, n° 173.

3. Mixed with lime; (n° 98).

THE FIFTH ORDER.

THE *Micaceous* kinds. The glimmer, daze, or gliff. 147

These are known by the following characters.

1. Their texture and composition consist of thin flexible particles, divisible into plates or leaves, having a shining surface.
2. These leaves, or scales, exposed to the fire, lose their flexibility, and become brittle, and then separate into thinner leaves: but in a quick and strong fire, they curl or crumple, which is a mark of fusion; though it is very difficult to reduce them into a pure glass by themselves, or without addition.
3. They melt pretty easily with borax, the microcosmic salt, and the alkaline salt; and may, by means of the blow-pipe, be brought to a clear glass with the two former salts. The martial mica is, however, more fusible than the uncoloured ones.

There is not yet discovered any loose earth of this kind, but it is always found indurated.

A. Colourless or pure mica; daze, glimmer, or gliff. 149

1. Of large parallel plates; Muscovy glass. Is transparent as glass; found in Siberia, and Elfdalen in the province of Wermeland in Sweden.
2. Of small plates; from Silfverberget, at Runneby, in the province of Blekinge, in Sweden.
3. Of particles like chaff; chaffy mica.
4. Of twisted plates; crumpled mica.

B. Coloured and martial glimmer.

1. Of large parallel plates; *Martialis*.

a. Brown semi-transparent.

2. Of fine and minute scales.

a. Brown.

b. Deep green.

c. Light green; *Talcum officinale*.

d. Black, found in granites.

3. Twisted or crumpled glimmer.

a. Light green, in the olaris.

4. Chaffy glimmer.

a. Black, is found in the stone called *hornberg*, which occurs in most of the Swedish copper-mines.

5. Crystallified glimmer; *Mica drusica*.

1. Of concentrated and erect scales.

2. Of hexagonal horizontal plates.

THE SIXTH ORDER.

The fluors, *Fluores minerales*. Suec. *Fluss-arter*. Germ. *Fluss-arten*.

These are commonly called *fluxing*, *vitrescent*, or *glass spars*, because most part of them have a sparry form 151



EARTHS. form and appearance: they are, however, often met with in an indeterminate figure.

These are only known in an indurated state; and distinguish themselves from the other earths by the following characters.

1. They are scarce harder than a calcareous spar, and consequently do not strike fire with steel.
2. They do not ferment with acids, neither before nor after calcination, notwithstanding a phlogiston or an alkali had been added in the calcination.
3. They do not melt by themselves, but only split to pieces when exposed to a strong fire. But,
4. In mixtures with all other earths, they are very fusible, and especially when they are blended with the calcareous earth, with which they melt to a corroding glass, which dissolves the strongest crucibles, unless some quartz or apyrus clay is added thereto.
5. When heated slowly, and by degrees, they give a phosphoreous light; but as soon as they are made red-hot, they lose this quality. The coloured ones, and especially the green, give the strongest light, but none of them any longer than whilst they are well warm.
6. They melt and dissolve very easily by the addition of borax, and next to that by the microcosmic salt, without ebullition.

152

## A. Indurated fluor.

(1.) Solid, of an indeterminate figure. Is of a dull texture, semi-transparent, and full of cracks in the rock.

a. White.

(2.) Sparry fluor has nearly the figure of spar, though, on close observation, it is found not to be so regular, nothing but the glossy surface of this stone giving it the resemblance of spar.

a. White. b. Blue. c. Violet. d. Deep green. e. Pale green. f. Yellow, from Giffos in Skone.

153

(3.) Crystallised fluor, when in single crystals; but fluor druse, when many crystals are heaped together.

1. Of an irregular figure.

a. White. b. Blue. c. Red.

2. Of a cubical figure.

a. Yellow. b. Violet.

3. Of a polygonal spherical figure.

a. White. b. Blue.

4. Of an octoëdral figure.

a. Clear and colourless.

## THE SEVENTH ORDER.

The *Asbestos* kind; *Asbestine*.

These are only yet discovered in an indurated state: their characters are as follow,

1. When pure they are very refractory in the fire.
2. In large pieces they are flexible.
3. They have dull or uneven surfaces.
4. In the fire they become more brittle.
5. They do not strike fire with the steel.
6. They are not attacked by acids.
7. They are easily brought into fusion by borax.

154

2

In this order are included both those varieties which by fossilogists have been mentioned under the names *amiant* and *asbesti*, and have often been confounded together.

EARTHS.  
*Asbestos*,  
*Zeolite*.

I. *Asbestos* which is compounded of soft and thin membranes; *Amiantus Wallerii*. 155

A. Of parallel membranes; *Corium*, five *caro montana*, mountain-leather.

1. Pure.

a. White.

2. Martial.

a. Yellowish brown, from Storrgrünningen, at Dannemora, in the province of Upsland. This melts pretty easily in the fire to a black slag, or glass.

B. Of twisted soft membranes, mountain-cork. 156

1. Pure.

a. White.

2. Martial.

a. Yellowish brown. This has the same quality in the fire as the martial mountain-leather.

II. Of fine and flexible fibres; *Asbestos*, or earth-flax; *Asbestos Wallerii*. 157

A. With parallel fibres; *Bysfus*.

1. Pure and soft.

a. Light green.

b. White.

2. A little martial, and more brittle.

a. Greenish; from Baftnas Grufva, at Ryd-darhyttan in Westmanland in Sweden. There it forms the greatest part of the vein out of which the copper ore is dug; a great part of it is consequently melted together with the ore, and is then brought to a pure semi-transparent martial slag or glass.

B. Of broken and recombined fibres. 158

1. Martial.

a. Light green.

## THE EIGHTH ORDER.

*Zeolites*.

This is described in its indurated state, in the Transactions of the Academy of Sciences at Stockholm for the year 1756; and there methodised as a stone *sui generis*, in regard to the following qualities: 159

1. It is a little harder than the fluors, and the calcareous kind: it receives however scratches from the steel, but does not strike fire with it.

2. It melts easily by itself in the fire, with a like ebullition as borax does, into a white frothy slag, which not without great difficulty can be brought to a solidity and transparency.

3. It is easier dissolved in the fire by the mineral alkali (*sul soda*), than by the borax and microcosmic salt.

4. It does not ferment with this last salt, as the lime does; nor with the borax, as those of the gypseous kind.

5. It dissolves very slowly, and without any effervescence, in acids, as in oil of vitriol and spirit of nitre. If concentrated oil of vitriol is poured on pounded zeolites, a heat arises, and the powder

powder unites into a mass (1).

6. In the very moment of fusion it gives a phosphorus or light.

The zeolites is found in an indurated flate.

(1.) Solid, or of no visible particles.

A. Pure; *Zeolites durus*.

a. White, from Iceland.

B. Mixed with silver and iron.

a. Blue; *Lapis lazuli*, from the Buckarian Calmucks. This, by experiments made with it, has discovered the following properties:

1. It retains for a long time its blue in a calcining heat, but is at last changed into a brown colour.
2. It melts easily in the fire to a white frothy slag; which, when exposed to the flame of a blow-pipe, is greatly puffed up, but in a covered vessel, and with a stronger heat, becomes clear and solid, with blue clouds in it.
3. It does not ferment with acids: but,
4. Boiled in oil of vitriol, it dissolves slowly, and loses its blue colour.

When a fixed alkali is added to this solution, a white earth is precipitated, which being scorified with borax, yields a silver regulus, that varies in bigness according to the various samples of the stone.

5. By scorification with lead, there has been extracted two ounces of silver out of 100 pounds weight of the stone.
6. The presence of silver is not discovered with the same certainty by the spirit of nitre as by oil of vitriol.
7. When the spirit of sal ammoniac is added to any solution, made either of crude or of a perfectly calcined lapis lazuli, there is no blue colour produced; which proves that this colour is not owing to copper, as some have pretended: and this is farther confirmed by the fixity of the blue colour in the fire (1, 2), and by the colour of the slag or glass (2).
8. It is a little harder than the other kinds of zeolites; but does not, however, in hardness approach to the quartz, or to other stones of the siliceous kind in general; because the purest and finest blue lapis lazuli may be rubbed with the steel to a white powder, although it takes a polish like marble.
9. The lapis lazuli, when perfectly calcined, is a little attracted by the loadstone; and scorified with lead, the slag becomes of a greenish colour, not such a colour as copper gives, but such as is always produced by iron mixed with a calcareous substance.

(2.) Sparry zeolites.

This resembles a calcareous spar; though it is of a more irregular figure, and is more brittle.

a. Light red, or orange-coloured; from Nya

Krongruvan, one of the gold-mines at Adelfors, in the province of Smoland.

- (3.) Crystallized zeolites is more common than the two preceding kinds; and is found,

A. In groups of crystals in form of balls, and with concentric points.

a. Yellow.

b. White.

B. Prismatic and truncated crystals.

a. White.

C. Capillary crystals are partly united in groups, and partly separate. In this latter accretion they resemble the capillary or feather filter ore; and is perhaps sometimes called *flus ferri*, at places where the nature of that kind of stone is not yet fully known.

These crystals are found,

a. White.

#### THE NINTH ORDER.

The *Manganese* kind; *Magnesia*.

The stones belonging to this order are in Swedish called *brunsten*, in Latin *sideræ*, or *magnesia nigra*; in order to distinguish them from the *magnesia alba officinalis*, and in French *manganese*, &c. They are by some lithographists entirely omitted, and by others ranked among the iron ores.

1. The manganese consist of a substance which gives a colour both to slags and to the solutions of salts, or, which is the same thing, both to dry and to liquid menstrua, viz.

a. Borax, which has dissolved manganese in the fire, becomes transparent, of a reddish brown or jacinth colour.

b. The microcosmic salt becomes transparent with it, of a crimson colour, and moulders in the air. c. With the fixed alkali, in compositions of glass, it becomes violet; but if a great quantity of manganese is added, the glass is in thick lumps, and looks black. d. Scorified with lead, the glass gets a reddish brown colour. e. The lixivium of a deflagrated manganese is of a deep red colour.

2. It deflagrates with nitre, which is a proof that it contains some phlogiston.

3. When reckoned to be light, it weighs as much as an iron ore of the same texture.

4. Being melted together with glass-compositions, it ferments during the solution; but it ferments in a still greater degree when it is melted with the microcosmic salt.

5. It does not excite any effervescence with the spirit of nitre: aqua regia, however, extracts the colour out of the black, and dissolves likewise a great deal of it, which, by means of an alkali, is precipitated to a white powder.

6. Such colours as are communicated to glasses by manganese, are easily destroyed by the calx of arsenic or tin: they also vanish of themselves in the fire.

7. It is commonly of a loose texture, so as to colour the fingers like foot, although it is of a metallic appearance when broke.

Manganese

(1) Other varieties of the zeolites have been discovered, particularly at Adelfors's gold-mines in Smoland in Sweden; of which some sorts do not melt by themselves in the fire, but dissolve readily in the acid of nitre, and are turned by it into a firm jelly.

*Manganese* Manganese is found,  
EARTHS.

A. Looße and friable,

a. Black, seems to be decayed particles of the indurated kind.

B. Indurated.

1. Pure, in form of balls, whose texture consists of concentric fibres.

a. White, *Magnesia alba friabilis sic dicta*, is very scarce. Mr Cronstedt saw a specimen of this kind in a collection from an unknown place in Norway; and by examining a piece of it, he found that it differed from the common manganese, by giving to the borax a deep red colour in the fire; this fort acquires a reddish brown colour when it is calcined.

b. Red manganese is said to be found in Piedmont. This Mr Cronstedt has never seen; but has been told that this variety is free from iron, and gives to glass rather a red than a violet colour.

2. Mixed with a small quantity of iron.

a. Black manganese, with a metallic brightness. This is the most common kind, and is employed at the glass-houses and by the potters. It is found,

1. Solid, of a slaggy texture; *Magnesia textura vitrea*.

2. Steel-grained.

3. Radiated.

4. Crystallised.

a. In form of coherent hemispheres.

3. Blended with a small quantity of iron and tin; *Spuma lupi*, or *Wolfram*.

Wolfram is a name which is also sometimes given to mock lead, and sometimes to cockle or shirl, as also to other minerals; however, it is chiefly given to this species of manganese, when it occurs in the tin mines.

1. With coarse fibres.

a. Of an iron colour. This gives to the glass compositions, and also to borax and the microcosmic salt, an opaque whitish yellow colour, which at last vanishes.

## SECOND CLASS.

THE SALTS. By this name those mineral bodies are called which can be dissolved in water, and give it a taste; and which have the power, at least when they are mixed with one another, to form new bodies of a solid and angular shape, when the water in which they are dissolved is diminished to a less quantity than is required to keep them in solution; which quality is called *crystallisation*.

No other salts ought to be considered and ranked in a mineral system but those which are found natural in the earth; and for this reason a great number of salts will be in vain looked for here, viz. all such as are either natural or prepared by art in the other two kingdoms of nature, and from substances belonging to them. Amongst these is nitre itself and its acid, and the vegetable acid, since these are never had from true mineral bodies; nor is it demonstrated that they have their origin from the true mineral vitriolic and muriatic acids. There have, indeed, been many

attempts made to reduce most of them to a vitriolic acid, which by many is called the *universal acid*: but experiments will not agree with it; at least nobody has yet been able, by uniting a phlogiston with any other acid than the true vitriolic, to produce a substance in every particular resembling the true brimstone, or sulphur.

In regard to the known principal circumstances or qualities of the mineral salts, they are divided into

1. Acid salts, or mineral acids.

2. Alkaline salts, or mineral alkalis.

### THE FIRST ORDER.

Acid salts; the characters of which are, that they

169

1. Have a sour taste.

2. Are corrosive; that is to say, have a power of dissolving a great number of bodies.

3. They have a strong attraction to the alkaline salts and earths, whence they always unite with them with an effervescence, and sometimes with a strong heat: by this mixture bodies are produced, which are employed in common life under the names of *vitriols*, *neutral salts*, *gypsum*, &c.

4. They change most of the expressed blue juices of vegetables into red.

5. They separate the alkali from the fat, when they have been united in soap; which effect is called *curdling* or *coagulation*.

6. They are volatile and subtle, so as never to be observable by the naked eye, unless they are mixed with heterogeneous bodies; and therefore the figure of the pure mineral acids cannot be defined but by gases.

A. The vitriolic acid; *Acidum vitrioli, aluminis, et sulphuris*.

170

1. The pure vitriolic acid is, in abstract, considered as possible to occur in nature: its qualities, when mixed with water, in which it is caught by distillation, are as follows:

1. When mixed with the least possible quantity of water, it is of an unctuous appearance, and is for that reason improperly called *oil of vitriol*.

2. It has in that state a considerable heaviness, viz. in comparison to water, as 1700 to 1000.

3. It dissolves silver, tin, the regulus of antimony, and quicksilver; but,

4. When mixed with more water, it dissolves zinc, iron, and copper.

5. It dissolves likewise the calcareous earth, and precipitates with it in form of a gypsum, of which a part shoots into gypseous drusen, *selenites* et *crystalli gypsei*.

6. It unites with the earth of quartz, when it has been previously dissolved in the *liquor silicium*; and with a pure argillaceous earth, dissolving it without any fermentation: with both these earths it makes alum.

7. It has a stronger attraction to the inflammable substance than to the alkaline salt, and forms with it a body which properly may be called the *mineral sulphur*.

8. When it is perfectly united with phlogistic substances belonging to the vegetable kingdom,

dom, and the water has been completely ferromated, this mixture catches flame in the open air, and is consumed; as may be seen by the powder called *pyrophorus*.

9. It attracts water strongly, and the aqueous vapours out of the air; and if a great quantity of water is added to it at once, a strong heat arises.
10. It unites readily and easily with the alkalis, whereby, according to their nature, different compounds are produced, which have obtained the names of *tartarus vitriolatus*, *sal mirabile*, and *sal ammoniacum fixum*.

II. The vitriolic acid mixed or saturated.

A. With metals; *Vitriola*, vitriols.

a. Simple vitriols.

1. Martial vitriol; green vitriol, or copperas.

This is the common green vitriol, which naturally is found dissolved in water, and is produced in abundance by decayed or calcined marcasites.

2. Copper vitriol; blue vitriol. This is of a deep blue colour, and is found in all ziment waters, as they are called; for instance, at Neusohl in Hungary, in St Johan's mine at Fallune in the province of Dalarnne, at Nya Kopparberget in Weltmanland, and the copper-mines at Wicklow in Ireland, &c. It is, however, seldom perfectly free from an admixture of iron and zinc.

3. Zinc vitriol, is white and clear as alum, and is found at the Ramelsberg in the Hartz, as also in the rubbish at Stollgrufvan in Weltmanland in Sweden, where the mock lead has decayed either spontaneously, or after having been burnt.

b. Compound vitriols.

1. Vitriol of iron and copper, is of a bluish green colour.
2. Vitriol of iron, zinc, and copper. This verges more to the blue than to the green colour. It is made at Fahlune in Dalarnne, from the water which is pumped out of the copper mines: in this water large crystals of vitriol are often ready formed. If this vitriol is dipped in water, and afterwards rubbed on clean iron, the copper does not precipitate from it.
3. Vitriol of zinc and iron. This is the green vitriol from Goslar in the Hartz.
4. Vitriol of zinc and copper. This is the blue vitriol from Goslar.
5. Vitriol of nickel and iron, is of a deep green colour, and is contained in the ochre or decayed parts of the nickell, at the cobalt-mines at Los, in the province of Helsingland.

Most part of the vitriols owe their formation to art: because when such ores as contain sulphur are dug out of the mines by means of fire, the phlogiston of the sulphur is by the heat expelled, leaving the

acid behind; which, being let loose or freed, is thereby enabled to attract and unite with watery vapours, dissolving at the same time the metals; and it is thus the vitriols are formed. Every fort of ore does not commonly decay or weather in a natural manner, without being promoted by art; and this decaying or weathering is mostly performed in the open air: for which reason no very great quantity of vitriol can be expected in that way; for when any ore thus weathers or decays, the dissolved particles are by degrees carried off by the rain, and are at last found in a dissolved state in certain springs or mineral waters. All such ores may therefore be called *true vitriol ores*, as contain iron, copper, zinc, and nickel mineralised with sulphur. The acid in the vitriols, however, is not dulcified by the metals, as it is by the alkali in the true neutral salts.

B. The acid of vitriol mixed or saturated with earths.

1. With a calcareous earth. Gypsum.

2. With an argillaceous earth. The alum kind.

a. With a small quantity of clay. Native or plumose alum.

Is found on decayed alum ores in very small quantities.

The gypsa and abesti, but more especially the latter, have been used through ignorance in most countries for plumose native alum, on account of the similarity of structure.

b. With a greater quantity of pure clay. White alum ore.

1. Indurated pale red alum ore. Is employed at Lumini, not far from Civita Vecchia in Italy, to make the pale red alum called *roche-alum*. This is, of all alum ores, the most free from iron; and the reddish earth which can be precipitated from it does not show the least marks of any metallic substance.

c. With a very large quantity of martial clay, which likewise contains inflammable substance. Common alum ore.

Is commonly indurated and flaty, and is therefore generally called *alum slate*.

It is found,

1. Of parallel plates, with a dull surface; from Andrarum in the province of Skone, Hunneberg, and Billingen in the province of Westergottland, Rodoen in the province of Jemtland, and the island of Oeland, &c.

2. Undulated and wedge-like, with a shining surface. This at first sight resembles pit-coal: it is found in great abundance in the parish of Nas in Jemtland.

c. Vitriolic acid united with phlogiston. The sulphur kind.

175

## D. Vitriolic acid saturated with alkaline salt.

## a. With the alkali of the common salt or sea-salt.

This is a neutral salt, prepared by nature as well as by art, containing more or less of iron, or of a calcareous earth, from which arises also some difference in its effects when internally used. It shoots easily into prismatic crystals, which become larger in proportion to the quantity of water evaporated before the crystallisation. When laid on a piece of burning charcoal, or else burnt with a phlogiston, the vitriolic acid discovers itself by the smell like to the *hepar sulphuris*.

It is found in a dissolved state in springs and wells, and in a dry form on walls, in such places where aphonitrum has effloresced through them, and the vitriolic acid has happened to be present; for instance, where marasites are roasted in the open air. This salt is often confounded with the aphonitrum, or a pure mineral alkali; and a learned dispute once arose, which of these salts ought with the greatest propriety to be called *natron*, *Baurach veterum*, *sal mirabile*, or *Epsom salt*; whereas it might easily have been decided by chemical experiments, if their qualities had been regarded in preference to their figures or their native places.

This may be called *English* or *Epsom salt*, when it has naturally as equal a copious portion of the calcareous earth as of the artificial one; but in regard to its effects, for which it has been most valued by Glauber, Mr Cronstedt has ranked all the less considerable varieties of this neutral salt, when natural, under the name of *sal mirabile*.

176

## B. Acid of common or sea-salt. This acid, considered in that state in which it can be had, viz. in mixture with water, has the following qualities:

1. It does not alter the fluidity of water, nor considerably augment its heaviness, as the vitriolic acid does.
2. It is somewhat less corrosive and four than the said vitriolic acid.
3. It strongly attracts the alkaline salts; but, however, is forced to quit them to the vitriolic acid, when that is added.
4. It dissolves the calcareous earth, and makes with it a substance called *sal ammoniacum fixum*.
5. When exposed to the fire, combined with a phlogiston, it burns with a yellowish green flame.
6. When highly concentrated and pure, as when it is distilled from common salt mixed with pipe-clay, it dissolves tin and lead: but less pure, it dissolves copper, iron, zinc, and the regulus of antimony: the copper is, however, more easily dissolved when it is in form of a calx, as the calces of quicksilver and cobalt likewise are.
7. It unites with silver dissolved in aquafortis, and with lead dissolved in aqua-regia, falling with them to the bottom in form of a white spongy mass. This precipitation, exposed to

the fire, still retains the acid, and melts with it into a glassy substance, which does not dissolve in water.

8. It is apt to attract the humidity of the air, and to promote the decaying of those dry substances with which it has been united.
9. Mixed with the spirit of nitre, it makes the solution called *aqua-regia*, which is the true liquid menstruum for gold.

This acid seems also, on certain occasions, to have got loose from those substances with which it had been originally united in the earth: the *sal ammoniacum naturale* at Solfatara in Italy, and the horn silver ore, appear to be proofs of this, as they seem to be the products of time.

## I. Mixed or fatiated acid of sea-salt.

## a. With earths.

1. With a calcareous earth; *sal ammoniacum fixum*.

This somewhat decays, or attracts the humidity of the air: it is found in abundance in the sea-water. See the calcareous kind, (91, &c.)

## b. With alkaline salts.

## (1.) With the fixed mineral alkali, or sea alkali; common salt, or sea-salt.

This shoots into cubical crystals during the evaporation; it crackles in the fire, and attracts the humidity of the air.

## a. Rock salt, fossil salt.

Occurs in form of solid strata in the earth.

## 1. With sealy and irregular particles.

## a. Grey, and

## b. White. These are the most common, but the following are rarer:

## c. Red,

## d. Blue, and

## e. Yellow, from Cracow in Poland, England, Salzberg, and Tirol.

## 2. Crystallised rock-salt.

## a. Transparent, from Cracow in Poland, &amp;c.

## B. Sea-salt.

Is produced from sea-water, or from the water of salt lakes, by evaporation in the sun, or by boiling.

The seas contain this salt, though more or less in different parts. In Siberia and Tartary, there are lakes that contain great quantities of salt.

## γ. Spring-salt.

## (2.) Saturated with a volatile alkali. Native sal ammoniac.

This is of a yellowish colour, and is sublimed from the flaming vents or crevices at the Solfatara near Naples.

c. United with phlogiston; amber, *succinum*.

## d. United with metals.

1. With silver; *Minera argenti cornea*, horn silver ore. The *bornertz* of the Germans.

## The SECOND ORDER.

## ALKALINE mineral salts.

These are known by their action on the above-mentioned acids when they are joined together, whereby

177

178

179

180

181

whereby a fermentation arises, and a precipitation ensues of such bodies as either of them had before kept in dissolution, uniting at the same time together; by which new compositions are made, that are called *neutral salts*, or *salia neutra*.

These alkaline salts are,

182

## I. Fixed in the fire.

A. Alkali of the sea, or of common salt.

## (1.) Pure.

This has nearly the same qualities with the lixivious salt which is prepared from the ashes of burnt vegetables; it is the same with the *sal sodæ*, or kelp, because the kelp is nothing else than the ashes remaining after the burning of certain herbs that abound with common salt; but which common salt, during the burning of those vegetables, has quitted its acid.

This,

1. Ferments with acids, and unites with them.
2. Turns the syrup of violets to a green colour.
3. Precipitates sublimate mercury in an orange-coloured powder.
4. Unites with fat substances to make soap.
5. Dissolves the siliceous earth in the fire, and makes glass with it, &c. It distinguishes itself from the salt of the pot-ashes, by the following properties: that,
6. It shoots easily into prismatical crystals; which
7. Fall to powder in the air, in consequence of their easily losing their humidity.
8. Mixed with the vitriolic acid, it makes the *sal mirabile*.
9. It melts easier; and perhaps it is also more conveniently applied in the preparation of several medicines.
10. It is somewhat volatile in the fire.

183

## (2.) Mixed with a small quantity of the calcareous earth.

This is so strongly united with the calcareous earth, that the latter enters with it into the very crystals of the salt: though, by repeated solutions, the earth is by degrees separated from it, and falls to the bottom after every solution. It grows in form of white frost on walls, and under vaults, and in places where it cannot be washed away by the rain. When it contains any considerable quantity of the calcareous earth, its crystals become rhomboidal, a figure which the calcareous earth often assumes in shooting into crystals; but when it is purer, the crystals shoot into a prismatical figure. This is a circumstance which necessarily must confuse those who know the salts only by their figure, and shews at the same time how little certainty such external marks afford in a true distinction of things. This salt is therefore very often confounded with the *sal mirabile*.

184

## (3.) Saturated with mineral acids. Neutral salts.

a. With the acid of sea-salt; common salt, sea-salt.

b. With the vitriolic acid; *sal mirabile*.

## B. Borax.

Many experiments have been made with this salt, in order to discover its origin and constituent parts, the most remarkable of which are mentioned under the article CHEMISTRY n° 170, and its following qualities are to be observed.

185

1. It swells and froths in the fire, as long as any humidity remains in it; but melts afterwards very easily to a transparent glass, which, as it has no attraction to the phlogiston, keeps itself in the form of a pearl on the charcoal when melted with the blow-pipe.
2. It changes the syrup of violets into green; and precipitates the solution of alum, and that of metals made with acids.
3. It unites with mineral acids to a neutral salt, which shoots into very fine and subtile hair-like crystals, and is called *sal sedativum*. In a certain composition it is volatile; and mixed with *litmus*, or *succus heliotropii*, and the syrup of violets, it discovers marks both of an alkali and an acid.
4. When it has been united with the vitriolic acid and a phlogiston, no *hepar sulphuris* is produced.
5. After being refined, it shoots into irregular figures: but the crystals, which form themselves after the first operation, and are called *tinical*, consist of octagonal prisms, flat at the extremities, and with their angles cut off or truncated.

II. Volatile. This perfectly resembles that salt which is extracted from animals and vegetables, under the name of *alkali volatile*, or *sal urinosum*, and is commonly considered as not belonging to the mineral kingdom; but since it is discovered not only in most part of the clays, but likewise in the sublimate of Solfatara near Naples, it cannot possibly be quite excluded from the mineral kingdom.

186

Its principal qualities are, That,

- a. In the fire it rises in a dry form, and volatilises in the air in form of corrosive vapours, which are offensive to the eyes and nose.
- b. It precipitates the solution of the mercurial sublimate into a white powder.
- c. It also precipitates gold out of *aqua regia*, and detonates with it.
- d. It has a reaction in regard to the acids, tho' not so strongly as other alkalies.
- e. It tinges the solution of copper blue, and dissolves this metal afresh, if a great quantity is added.
- f. It desagrates with nitre, which proves that it contains a phlogiston.

It is never found pure; but,

A. Mixed,

1. With salts.
  - a. With the acid of common salt. Native sal ammoniac.
  2. With earths.

187

a. Clay.

INFLAMMABLES.  
Ambergiste,  
Amber.

INFLAMMABLES.  
Rock-oil.  
Sulphur.

a. Clay. The greatest part of the clays contain a volatile alkali, which discovers itself in the distillation of the spirit of sea-salt, &c.

2. Rock-oil; *Petroleum*, properly so called. This smells like the oil of amber, though more agreeable, and is likewise very ready to take fire. It is collected in the same manner as the naphtha, from some wells in Italy, and in a deserted mine at Ofmundberget in the province of Dalarna in Sweden: at this last-mentioned place it is found in small hollows in the limestone, as resin is in the wood of the pines.

THIRD CLASS.

Mineral INFLAMMABLE SUBSTANCES.

To this class belong all those subterraneous bodies that are dissoluble in oils, but not in water, which they repel; catch flame in the fire; and are electrical.

It is difficult to determine what constitutes the difference between the purer sorts of this class, since they all must be tried by fire, in which they all yield the same product; but those which in the fire shew their differences by containing different substances, are here considered as being mixed with heterogeneous bodies: that small quantity of earthy substance, which all phlogista leave behind in the fire, is, however, not attended to.

B. Thick and pitchy rock-oil, or Barbadoes tar; *Petroleum tenax, maltha*. Resembles soft pitch. 193

C. Hardened rock-oil; *Petroleum induratum*. Fossil pitch; *Pix montana*. 194

1. Pure; *Asphaltum*. This leaves no ash or earthy substance when it is burnt. From this or the preceding substance, it is probable the asphaltum was prepared that the Egyptians used in embalming their dead bodies, and which is now called *mummiæ*.

2. Impure; *Pix montana impura*. This contains a great quantity of earthy matter, which is left in the retort after distillation, or upon the piece of charcoal if burnt in an open fire; it coheres like a slag, and is of the colour of black lead: but in a calcining heat this earth quickly volatilises; so that the nature of it is not yet known. The substance which rises, and then falls into the receiver during the distillation of this fossil pitch, is entirely the same as the common natural liquid rock-oil.

IV. Mineral phlogiston, or bitumen, united with the vitriolic acid. Sulphur, or brimstone. This is very common in the earth, and discovers itself in many and various forms. It is found, 195

A. Native sulphur. In this the two constituent parts are mixed in due proportion in regard to each other, according to the rules of that attraction which is between them; it is easily known,

1. By its inflammability, and by its flame.
2. By its smell when burnt; and,
3. By its producing a liver of sulphur, when mixed with a fixed alkali, like that made from artificial sulphur.

It is found,  
a. Pellucid, of a deep yellow colour.  
b. Opaque, white, and greyish. It is often found on limestone, which the vitriolic acid has left untouched, having a stronger attraction to the phlogiston, and therefore wholly uniting with that.

B. Sulphur that has dissolved or is saturated with metals. 196

1. With iron. Pyrites, or copperas-stone; *Pyrites*. This is the substance from which most sulphur is prepared, and is therefore ranked here with all its varieties. It is hard, and of a metallic shining colour.

a. Pale yellow pyrites; *Pyrites subflavus*. Marcasite. This is very common, and contains a proportionable quantity of sulphur with respect to the iron; when once thoroughly inflamed, it burns by itself.

188

I. Ambergiste, is commonly reckoned to belong to the mineral kingdom, although it is said to have doubtful marks of its origin.

- a. It has an agreeable smell, chiefly when burnt.
- b. It is consumed in an open fire.
- c. It softens in a gentle degree of heat, so as to stick to the teeth like pitch.
- d. It is of a black or grey colour, and of a dull and fine-grained texture. The grey is reckoned the best, and is sold very dear.

189

II. Amber. *Ambera fluxa; succinum; electrum*. There are often found fish, insects, and vegetables included in it, which testify its once having been liquid. It is more transparent than most part of the other bitumens, and is doubtless that substance which first gave rise to electrical experiments.

Its varieties are reckoned from the colour and transparency: it is found,

- A. Opaque.
  - a. Brown.
  - b. White.
  - c. Blackish.
- B. Transparent.
  - a. Colourless.
  - b. Yellow. The greatest quantity of European amber is found in Prussia; but it is, besides, collected on the sea-coast of the province of Skone, and at Bjorko, in the Lake Malaren, in the province of Upland; as also in France and in Siberia. It is chiefly employed in medicines, and for making varnishes.

190

III. Rock-oil; *Petroleum*. It is an inflammable mineral, of a light-brown colour, which cannot be decomposed, but is often rendered impure by heterogeneous admixtures. In length of time, it hardens in the open air, like a vegetable resin; and then becomes of a black colour, whether it is pure, or mixed with other bodies. It is likewise found in the earth.

- A. Liquid.
  1. Naphtha. This is said to be of a very fragrant smell, transparent, extremely inflammable, and attracts gold. It is gathered from the surface of the water in some wells in Persia.

191

197

- a. Of a compact texture; *Polita piedra del yuca, Hispanorum.*  
 b. Steel-grained.  
 c. Coarse-grained.  
 d. Crystallised. It shoots mostly into cubical and octoëdral figures, tho' it also crystallises into innumerable other forms.
- b. Liver-coloured marcasite. Its colour cannot be described, being betwixt that of the preceding marcasite, and the azure copper ore. The iron prevails in this kind; it is therefore less fit to have sulphur extracted from it, and also for the smelting of copper ores. It is found,  
 a. Of a compact texture.  
 b. Steel-grained.  
 c. Coarse-grained.

198

- z. Iron and tin. Black-lead, or wadd; *Molybdæna*. If by such a mixture as this the iron and tin be not rendered too volatile, it must be supposed that the great loss the black lead sustains in the calcining heat is occasioned from the sulphur, and that the sulphur consequently makes out the greatest part of the black lead. It is found,  
 a. Lamellar and shining, of the same colour as the potters lead ore.  
 b. Of a steel-grained and dull texture. It is naturally black, but when rubbed it gives a dark lead colour.  
 c. Of a fine scaly and coarse-grained texture; coarse black lead. It has at the same time a scaly and a granulated appearance. From Gran in the province of Upland, and from Tawastehuslan in Finland. Professor Pott has examined the black lead in covered vessels, and Mr Quill in an open fire; from which difference in the method of treating it, different notions have arisen: because the black lead is nearly unalterable when exposed to the fire in covered vessels, or when immediately put into a strong charcoal fire, but it is almost wholly volatile in a calcining heat. This is the case with several others of the mineral phlogistons; and from this we may in general learn, how necessary it is to examine the mineral bodies by many and different methods, and to endeavour to multiply the experiments more than what has been hitherto done.
3. Sulphur with iron and copper; yellow or marcasitical copper ore.  
 4. Sulphur with iron and lead; potters lead-ore.  
 5. Sulphur with iron and zinc; mock lead, black jack, or blende.  
 6. Sulphur with iron and arsenic; arsenical pyrites.  
 7. Sulphur with iron and cobalt.  
 8. Sulphur with iron and bismuth.  
 9. Sulphur with iron and nickel.  
 10. Sulphur with iron and gold; pyritical gold ore.  
 11. Sulphur with silver; glass silver ore,

199

12. Sulphur with copper; grey or vitreous copper ore.  
 13. Sulphur with lead; potters lead ore.  
 14. Sulphur with bismuth.  
 15. Sulphur with quicksilver; cinnabar.  
 16. Sulphur with arsenic, orpiment, *realgar*.
- V. Mineral phlogiston united with earths.
- A. With a calcareous earth.  
 1. With pure calcareous earth; the fetid or swine spar.  
 2. With the calcareous earth and vitriolic acid; the *leberstein* or *liverstone* of the Swedes.  
 B. With an argillaceous earth.  
 1. With a small quantity of argillaceous earth and vitriolic acid: Coal; *Lithantrax*. It is of a black colour, and of a shining texture; it burns, and is mostly consumed, in the fire; but leaves, however, a small quantity of ashes.  
 a. Solid coal. b. Slatty coal.  
 2. With a greater quantity of argillaceous earth and vitriolic acid; the *kohn* of the Swedes. This is of the same appearance with the former, though of a more dull texture; it burns with a flame, and yet is not consumed, but leaves behind a slag of the same bulk or volume as the coal was.  
 3. With abundance of argillaceous earth; stone coal. It burns with a flame by itself, otherwise it looks like other slates.
- VI. Mineral phlogiston mixed with metallic earths. 201
- This is not found in any great quantity: in regard to its external appearance, it resembles pit-coal; and the fat substance contained in it, at times, partly burns to coal, and partly volatilises in a calcining heat.
- The only known varieties of this kind are,  
 A. *Minera cupri phlogistica*.  
 When it has been inflamed, it retains the fire, and at last burns to ashes, out of which pure copper can be melted.  
 B. *Minera ferri phlogistica*.  
 This is not very different in its appearance from the pit-coal or fossil pitch, but it is somewhat harder to the touch. There are two varieties of this species:  
 1. Fixt in the fire; *Minera ferri phlogistica fixa*.  
 Exposed to a calcining heat, it burns with a very languid though quick flame; it preserves its bulk, and loses only a little of its weight. It yields above 30 per cent. of iron.  
 a. Solid, resembles black sealing-wax. — It is found in the liver-coloured marcasite in Walkberget, at Norrberke in Weitmanland.  
 b. Cracked, and friable.  
 2. Volatile in the fire.  
 This is unalterable in an open fire, either of charcoal, or even upon a piece of charcoal before the flame of the blow-pipe; but under a muffle the greatest part of it volatilises, so that only a small quantity of calx of iron remains. It is found,  
 a. Solid.  
 b. Cracked.  
 This last kind leaves more ashes: these

200

201

ashes,



ashes, when farther exposed to the fire, become first yellowish-green, and afterwards reddish-brown, when, besides iron, they then also discover some marks of copper; it has, however, not been possible to extract any metallic substance from them, the effects of the loadstone, and the colour communicated to the glass of borax, having only given occasion to this suspicion.

FOURTH CLASS.

METALS.

202 ARE those mineral bodies which, with respect to their volume, are the heaviest of all hitherto-known bodies; they are not only malleable, but they may also be decomposed, and in a melting heat be brought again to their former state, by the addition of the phlogiston they had lost in their decomposition.

Those metals which in a calcining heat lose their phlogiston, and consequently with that the former coherency of their particles, are called *imperfect*; as tin, lead, copper, and iron, and all the semi-metals (of which more hereafter): notwithstanding which, they may be malleable. But those which cannot be destroyed in the fire alone are called *perfect*; as gold, silver, and platina del pinto. Nevertheless, the metals have commonly been considered more with regard to their malleability than to their fixity in the fire; and are therefore divided into,

A. Malleable, which are called *metals*; and,

B. Brittle, which are called *semi-metals*.

The zinc is, however, as a medium between these two divisions, just as the quicksilver is between the perfect and imperfect metals; because the quicksilver may indeed be so far destroyed in the fire, that its particles are separated during their volatilisation; but every one of them, even the minutest, retains, however, the phlogiston united with it.

The FIRST ORDER. True Metals.

203 I. GOLD; *Aurum, sol chymicumum.*

This is by mankind esteemed as the principal and first among the metals; and that partly for its scarcity, but chiefly for the following qualities:

1. It is of a yellow shining colour.
2. It is the heaviest of all known bodies, its specific gravity to water being as 19,640 to 1000.
3. It is the most tough and ductile of all metals; because one grain of it may be stretched out so as to cover a silver wire of the length of 98 yards, by which means  $\frac{1}{100000}$  grain becomes visible to the naked eye.
4. Its softness comes nearest to that of lead, and consequently it is but very little elastic.
5. It is fixed and unalterable in air, water, and fire, because it does not easily quit its phlogiston; its liquid menstruum being only made by art.

It has, however, according to Homberg's experiments, when exposed to Tschirnhausen's burning-glass, been found partly to volatilise

in form of smoke, and partly to scoriify: but this wants to be farther examined. It is also said, that gold, in certain circumstances, and by means of certain artifices in electrical experiments, may be forced into glass; and that on this occasion it becomes white, leaving a black dust behind it; which, if so, confirms certain other chemical experiments, viz. That gold can, together with its colour, lose something of its phlogiston, and yet retain its heaviness, ductility, &c.

6. When melted, it reflects a bluish-green colour from its surface.
7. It dissolves in aqua regia, which is composed of the acids of sea-salt and nitre; but not in either alone, nor in any other solution of salt or acid whatsoever.
8. When mixed with a volatile alkali and a little of the acid of nitre, by means of precipitation out of aqua regia, it burns off quickly, in the least degree of heat, with a strong fulmination.
9. It is dissolved, *in forma sicca*, by the liver of sulphur, and also somewhat by the glass of bismuth.
10. It is not carried away by the antimony during the volatilisation of that semi-metal, and is therefore conveniently separated from other metals by the help of crude antimony; in which process the other metals are partly made volatile, and fly off with the antimony, and partly united with the sulphur, to which the gold has no attraction, unless by means of some uniting body, or by a long digestion.
11. The phosphorus is said to have ingressed into gold.
12. If mixed with a less portion of silver, platina, copper, iron, and zinc, it preserves tolerably well its ductility. But,
13. When mixed with tin, it becomes very brittle; and it attracts likewise the smoke of that metal so as to be spoiled, if melted in an hearth where tin has been lately melted: And this is perhaps the reason why gold becomes brittle, and of a paler colour, when melted in a new black lead crucible.
14. It requires a strong heat before it melts, nearly as much, or a little more than copper.
15. It mixes or amalgamates readily with quicksilver.

A. Native gold is in its metallic form commonly pure: and in this state most part of this metal used in the world is found. With respect to either the figure or the quantity in which it is found in one place, it is by miners divided into,

1. Thin superficial plated or leaved gold; which consists of very thin plates or leaves, like paper.
2. Solid or massive, is found in form of thick pieces.
3. Crystallised, consists of an angular or crystalline figure.
4. Wash gold, or gold dust, is washed out of sands, wherein it lies in form of loose grains

and lumps. The gold is in general more frequently imbedded and mixed with quartz than with any other kind of stone; and the quartz in which the gold is found in the Hungarian gold mines is of a peculiar appearance. All other sorts of stones, however, are not to be excluded, since gold is likewise found in some of them; for instance, in limestone, in Adolph Fredrik's Grufva at Adelfors in the province of Smoland in Sweden; in Hornblende, in Baitnas Grufva at Riddarhyttan in the province of Westmanland; not to mention several other gold mines.

205

**B. Mineralised gold.** This is an ore in which the gold is so far mineralised, or so entangled in other bodies, as not to be dissolved by the aqua regia.

1. Mineralised with sulphur.

*a.* Mineralised by means of iron. Marcasitical gold ore; *Pyrites aureus*. It is found at Adelfors, in the province of Smoland; and contains an ounce of gold, or less, in 100 pounds.

*b.* Mineralised by means of quicksilver. It is found in Hungary.

*c.* Mineralised by means of zinc and iron; *Aurum sulphure mineralisatum mediante zinco & ferro, aut argento*. The Schemnitz blende. At Schemnitz in Hungary are found zinc ores, which contain a great deal of silver, and this silver is very rich in gold. Since gold and sulphur have no immiscible power or attraction to one another, many have insisted that gold never could be found in marcasite, or those ores which contain sulphur: but since we know by experience that gold can be melted out of the above-mentioned ores, although they have been previously digested in aqua-regia; and that gold likewise mixes and dissolves into a regulus; there is the greatest reason to believe that a third substance, which here is a metal, must necessarily have by its admixture enabled the sulphur to unite with a certain quantity of gold. Scheffer has given upon this subject some very curious and useful observations, in his History of the Refining of Metals, inserted in the Transactions of the Academy of Sciences at Stockholm.

It is, however, by no means hereby intended to confirm the credulous in their opinion, that the marcasites in general contain more gold than what true metallurgists have asserted; because fraud might then perhaps become too common. It is only meant to indicate, that, as no gold is to be expected from marcasites, where no native gold is found in the neighbourhood, in the same manner no marcasites ought to be despised which are found in tracks where gold ores are dug: but at the same time care must be taken not to be deluded by the mention of volatile

gold, as it is a notion really contradictory and suspicious; and then there can be no fear of being misled.

II. Silver; *Argentum, luna*. Which is,

*a.* Of a white shining colour.

*b.* Its specific gravity to water is 11,091 to 1000.

*c.* It is very tough or ductile, so that a grain of it may be stretched out to three yards in length, and two inches in breadth.

*d.* It is unalterable in air, water, and fire.

*e.* It dissolves in the acid of nitre, and also by boiling in the acid of vitriol.

*f.* If precipitated out of the acid of nitre with the common salt, or with its acid, it unites so strongly with this last acid, that it does not part from it, even in the fire itself, but melts with it into a mass like glass, which is called *luna cornea*.

*g.* It does not unite with the semi-metal nickel, during the fusion.

*h.* It amalgamates easily with quicksilver.

*i.* It is in the dry way dissolved by the nitre of sulphur.

*k.* It has a strong attraction to sulphur, so as readily to take a reddish yellow or black colour, when it is exposed to sulphureous vapours.

*l.* It has no attraction to arsenic; whence, when the red arsenical silver ore, or *rotguldertz* of the Germans, is put into the fire, the arsenic flies off, and leaves the sulphur (which in this compound was the *medium uniens*) behind, united with the silver in form of the glass silver ore, or glass *ertz*.

*m.* It is not dissolved by the glass of lead, and consequently it remains on the cupel.

*n.* It is exhaled or carried off by volatile metals and acids, as by the vapours of antimony, zinc, and the acid of common salt.

*o.* It melts easier than copper.

Silver is found,

*A.* Native or pure.

Native silver most generally is nearly of sixteen carats standard.

1. Thin superficial plated or leaved silver.

2. It is also found in form,

*a.* Of faggots, and coarse fibres.

*b.* Of fine fibres. Capillary silver.

*c.* Arborescent. From Potosi in America, and Kongsberg in Norway.

*d.* Crystalline, or figured. This is very scarce to be met with: it has distinct figures, with shining surfaces; it is, however, sometimes found at Kongsberg.

The silver from America is said to be found for the most part native; so it is likewise at Kongsberg in Norway; but it is not commonly so in the other European mines. In Sweden, it is found native in a very small quantity, in the mines of Salberg in Westmanland, of Lofaten in Dalarna, of Hevasfwik and Sladkier in the province of Dal, of Sunnerkog in the province of Smoland, and in the island Utoen in the Lake Malaren. It was once found in pretty large lumps in a

vein

206

207

vein of clay in one of the iron mines at Normark, in the province of Wermeland. It was there mixed with nickel, which was partly decayed or withered; and under this circumstance it formed the compound ore called the *fiercus anserinum*, or *goose-dung ore*. At this place the argillaceous vein crosses the veins of the iron ore, and will perhaps be found to have more of these riches, even in several other places, if well searched, as is done in other countries, oftentimes not on such evident marks or signs.

## B. Dissolved and mineralised.

- (1.) With sulphur alone. Glass silver ore, This is ductile, and of the same colour as lead; but, however, becomes blacker in the air. It has, therefore, very undeservedly got the name of *glass-ore*; for that name rather belongs to the *minera argenti cornea*, or horn silver ore, if indeed any silver ore can be considered as glassy.

It is found in the same manner as native gold; viz.

1. In cruds, plates, or leaves.
2. Grown into
  - a. Snaggs, and
  - b. Crystalline figures.

It is generally either of a lamellar or a grained texture, and is found at Kongberg and in the Saxon mines.

The glass silver ore is the richest of all silver ores; since the sulphur, which is united with the silver in this ore, makes out but a very small quantity of its weight.

- (2.) With sulphur and arsenic. The red or ruby-like silver ore. The *rothgulden* of the Germans.

The colour of this ore varies as the proportion of each of these ingredients varies in the mixture; viz. from dark grey to deep red: but when it is rubbed or pounded, it always gives a red colour. When put in the fire, it crackles and breaks; and when the crackling ceases, it melts easily, the arsenic at the same time exhaling in smoke.

- a. Grey arsenical silver ore: which is either,
1. Plated, crufted, or leaved; and,
  2. Solid.
- b. The red arsenical silver ore:
1. Plated, crufted, or leaved;
  2. Solid or scaly; and,
  3. Crystallised.

In this last form it shows the most beautiful red colour, and is often semi-transparent. It contains about 60 per cent. in silver; and is found in the greatest quantity at Andreasberg in the Hartz.

- (3.) With sulphurated arsenic and copper. The *weissgulden* of the Germans.

This, in its solid form, is of a light grey colour, and of a dull and steel-grained texture. The more copper it contains, the

darker is the colour. It often holds seven pounds of silver per cent. It is,

a. Friable, withered, or decayed, of a black or sooty colour; and is therefore by the Germans called *filser-schwartz*, or *Ruffigtes-ertz*.

b. Solid, of a light grey colour, and is that sort properly called *weissgulden*.

It is found at St Mary of the Mines in Alfatia, the Saxon mines, and at St Andreasberg in the Hartz.

- (4.) With sulphurated arsenic and iron. The *weifertz*, or white silver ore, of the Germans.

This is an arsenical pyrites, which contains silver; it occurs in the Saxon mines, and so exactly resembles the common arsenical pyrites as not to be distinguished from it by sight alone, or without other means. The silver it contains may perhaps consist of very subtle capillary silver mixed in it.

- (5.) With sulphurated antimony.

a. Of a dark-grey and somewhat brownish colour. The *leberertz*, from Braunsdorff in Saxony.

b. Of a blackish blue colour.

1. In form of capillary crystals. *Federertz*, or plumose silver ore.

It is found in Saxony, and contains only two or four ounces of silver per cent.

- (6.) With sulphurated copper and antimony. The *Dal falertz*.

This resembles, both in colour and texture, the dark-coloured *weissgulden*, or *falertz*. When rubbed, it gives a red powder.

a. Solid.

b. Crystallised, is found in the parish of Aminskog in the province of Dal; and at that place has been for several years melted by a method invented for the different mixture of the ores; which process must be very troublesome to those who are not perfectly well versed in metallurgy.

It contains 13 ounces of silver, and 24 per cent. of copper.

- (7.) With sulphurated zinc. The *pechblende* of the Germans.

This is a zinc ore, mock lead, or blende, which contains silver, and is found among rich silver and gold ores; for instance, in the Hungarian and Saxon mines.

a. Of a metallic changeable colour:

1. Solid, and with fine scales.
2. In form of balls. The *kugel-ertz*, or ball ore.

It is found at Schemnitz, and contains also gold. Its yield of silver is 24 ounces per cent. and 30 per cent. of zinc.

b. Black mock lead, or blende, found in Saxony. This is also found,

1. Solid, and with fine scales;
2. And in form of balls.

- (8.) With sulphurated lead; potters ore. *Galena*, *bleyglanz*.

(9.) With

(9.) With sulphurated lead and antimony, called *Sripersz*.

(10.) With sulphurated iron. *Silberhaltiger kies*; marcasite holding silver.

At Kongberg in Norway, it is said, a liver-coloured marcasite is often found, particularly at the mine called *Fraulein Christiana*, &c. This marcasite contains of silver from three ounces to three and an half *per cent*.

(11.) With the acid of common salt. *Minera argenti cornua*. *Hornertz*, or horn-silver ore.

This is the scarcest silver ore; it is of a white or pearl colour, changeable or varying on the surface, semi-transparent, and somewhat ductile both when crude and when melted. It cannot be decomposed without some admixture of such substances as attract the acid of the sea-salt. It is found in very thin wrought leaves or crusts, at Johan Georgenstadt, in Saxony.

217

### III. Platina del Pinto; *Juan blanca*.

This metal is a recent discovery of our times; and is described with great accuracy by Scheffer, in the Acts of the Royal Academy of Sciences at Stockholm for the year 1752; as also by Dr Lewis, in the Philosophical Transactions for the year 1754, vol. xlviii. And though these two gentlemen agree in the principal circumstances relating to this metal, yet it is very plain by their descriptions, that neither of them knew any thing of the other's experiments. By these descriptions we are convinced of the resemblance this metal bears to gold; and therefore we must allow it to be called *white gold*, though, both theoretically and practically, it may be distinguished from gold by the following qualities.

1. It is of a white colour.
2. It is so refractory in the fire, that there is no degree of heat yet found by which it can be brought into fusion by itself, the burning-glass excepted, which has not yet been tried. But, when mixed with other metals and semi-metals, it melts very easily, and especially with arsenic, both in its metallic form and in form of a calx or glass.
3. It does not amalgamate with quicksilver by itself, but only by means of the acid of common salt after a long trituration. This metal is therefore really separated from gold by amalgamation, at those places where it is found; and without this quality it would be very difficult to separate it.
4. It is harder and less coherent than gold.
5. It is heavier than gold; and therefore the heaviest of all bodies hitherto discovered: for though the specific gravity of platina, in the hydrostatical experiments made by Dr Lewis, is found to be to water only as 17,000 to 1000; yet, when melted with other certain metals, its specific gravity has, by an exact calculation, been found to be considerably augmented, even so much as to 22,000.
6. Dissolved in aqua regia, and precipitated with tin, or with a solution of that metal, it yields no *purpura mineralis*.

Except these, this metal has the same qualities as gold: but it cannot, on account of its refractoriness in the fire, be worked off pure on the cupel, nor can it be worked with antimony; because, before it is rendered perfectly pure, it cools, grows hard, and retains always some part of the added metals. It is brought to us only in its native state, in small, irregular, rugged grains; and it is yet uncertain whether it is found naturally mineralised. The platina is brought to Europe from the Rio del Pinto, in the Spanish West Indies.

### IV. Tin; *Stannum*, *Jupiter*.

219

This is distinguished from the other metals by the following characters and qualities.

- a. A white colour, which verges more to the blue than that of silver.
- b. It is the most fusible of all metals; and,
- c. The least ductile; that is, it cannot be extended or hammered out so much as the others.
- d. In breaking or bending it makes a crackling noise.
- e. It has a smell particular to itself, and which cannot be described.
- f. In the fire it is easily calcined to white ashes, which are 25 *per cent*. heavier than the metal itself. During this operation, the phlogiston is seen to burn off in form of small sparkles among the ashes, or calx.
- g. This calx is very refractory; but may, however, with a very strong degree of heat be brought to a glass of the hard resin. But this calx is easily mixed in glass compositions, and makes with them the white enamel.
- h. It unites with all metals and semi-metals; but renders most of them very brittle, except lead, bismuth, and zinc.
- i. It amalgamates easily with quicksilver.
- k. It dissolves in aqua-regia, the spirit of sea-salt, and the vitriolic acid; but it is only corroded into a white powder by the spirit of nitre.

The vegetable acid, soaps, and pure alkaline salts, also corrode this metal by degrees.

- l. Its specific gravity to water is as 7400 to 1000, or as 7321 to 1000.
- m. Dissolved in aqua-regia, which for this purpose ought to consist of equal parts of the spirit of nitre and sea-salt, it heightens the colour of the cochineal, and makes it deeper; for otherwise that dye would be violet.

Tin is not found naturally in the earth in any other state than,

220

(1.) In form of a calx.

A. Indurated, or vitrified.

1. Mixed with a little of the calx of arsenic.

A. Solid tin ore, without any determinate figure; tin-stone.

It resembles a garnet of a blackish-brown colour, but is a great deal heavier; and has been considered, at the English tin-mines, as a stone containing no metal, until some years ago it began to be smelted to great advantage.

2. Crystallised; tin-grains.

Is like the garnets, of a spherical polygonal

True  
METALS.  
Lead.

True  
METALS.  
Lead.

polygona figure, but looks more unctuous on the surface.

1. In larger grains; and,
2. In smaller grains.
3. Mixed with the calx of iron.
4. Mixed with the manganese.
4. Mineralised with sulphur and iron; black lead.

V. Lead; *Plumbum, Saturnus*. It is, a. Of a bluish-white colour when fresh broke, but soon dulls or sullies in the air.

b. Is very heavy; viz. to water as 11,325 to 1000.

c. Is softest next to gold; but has no great tenacity, and is not in the least sonorous.

d. It is easily calcined; and, by a certain art in managing the degrees of the fire, its calx becomes white, yellow, and red.

e. This calx melts easier than any other metallic calx to a glass, which becomes of a yellow colour, and semi-transparent. This glass brings other bodies, and the imperfect metals, into fusion with it.

f. It dissolves, 1st, In the spirit of nitre; 2dly, In a diluted oil of vitriol, by way of digestion; 3dly, In the vegetable acid; 4thly, In alkaline solutions; and 5thly, In expressed oils, both in the form of metal and of calx.

g. It gives a sweet taste to all solutions.

h. It amalgamates with quicksilver.

i. With the spirit of sea-salt it has the same effect as silver, whereby is produced a *saturnus cornu*.

k. It does not unite with iron, when it is alone added to it in the fire.

l. It works on the cupel, which signifies that its glass enters into certain porous bodies, destitute of phlogiston and alkaline salts.

m. It melts in the fire before it is made red-hot, almost as easily as the tin.

n. Its calx or glass may be reduced to its metallic state by pot-ashes.

Lead is found,

A. In form of a calx.

(1.) Pure.

A. Friable; lead ochre; native cerufs. This is found at Kriftersberget in Westmanland in Sweden, on the surface of the potter's ore.

B. Indurated; lead spar, or spatose lead ore.

1. Radiated, or fibrous.

a. White.

2. Crystallised into a prismatical figure.

a. White.

b. Yellowish green.

(2.) Mixed.

A. With the calx of arsenic; arsenic lead-spar.

1. Indurated.

a. White. Mr Cronstedt has tried such an ore from an unknown place in Germany, and found that no metallic lead could be melted from it by means of the blow-pipe, as can be done out of other lead spars; but it must be performed in a crucible, and then that part

of the arsenic which did not fly off in smoke during the experiment was likewise reduced, and found in form of grains dispersed, and forced into the lead. Another ore of this kind, which likewise was not easily reduced by means of the blow-pipe, did always, after being melted, and during the cooling, hastily shoot into polygona, but mostly hexagonal, crystals, with shining surfaces. Can this crystallisation be owing to salts, which are said not to act in this manner but when they are dissolved in water?

b. With a calcareous earth.

The above-mentioned lead ores are very rich in lead, and easy to be tried; because most of them, being slowly heated, may be reduced to lead by means of the blow-pipe on a piece of charcoal. The calx of the lead in these ores has, perhaps, first been dissolved by sulphur and arsenic; and has afterwards, when these two have weathered away or decayed, and parted from it, assumed this form, in the same manner as we see it really happens, during the calcination, with rich lead ores, or such regulus as contain lead. The same, very likely, is the case with other metals; for which reason their ores, when they occur in form of a calx, often contain a little sulphur, and more especially arsenic.

B. Mineralised.

1. With sulphur alone: the *bley-schwweif*, or *bley-glans*, of the Germans.

a. Steel-grained lead-ore; from the mines at Hellefors, in the province of Westmanland.

b. Radiated, or antimoniated lead-ore.

c. Tefellated, or potter's lead-ore.

At Villach in Austria there is said to be found a potter's lead-ore, which contains not the least portion of silver.

2. With sulphurated silver. *Galena*; also called *bleyglanz*, by the Germans.

a. Steel-grained.

b. With small scales; is found at Selberg, and is there particularly called *bley-schwweif*.

c. Fine-grained.

d. Of a hue cubical texture; and,

e. Of coarse cubes. These two varieties are found in all the Swedish silver-mines.

f. Crystallised.

The steel-grained and scaly ores are of a dim and dull appearance when they are broke, and their particles have no determined angular figure: they are therefore in Swedish commonly called *bley-schwweif*; in opposition to the cubical ores, which are called *bleyglanz*. The most part of the ores called *bleyglanz* contain silver, even to 24 ounces per cent. of which we have instances in the mines of Salberg, where it has been observed, that the coarse cubical lead ores are generally the richest in silver, contrary to what

224

225

223

222

223

what is commonly taught in books; the reason of which may perhaps be, that, in making the essays on these two ores, the coarse cubical can be chosen purer or freer from the rock than the fine cubical ores.

226 3. With sulphurated iron and silver. This is found, a. Fine-grained. b. Fine cubical. c. Coarse cubical. When this ore is scorified, it yields a black slag; whereas the preceding lead-ores yield a yellow one, because they do not contain any iron.

227 4. With sulphurated antimony and silver; antimoniated or radiated lead-ore. This has the colour of a blyglanz, but is of a radiated texture.

It is found,

- a. Of fine rays and fibres; and,
- b. Of coarse rays or fibres. The lead in this ore prevents any use being made of the antimony to advantage; and the antimony likewise in a great measure hinders the extracting of the silver.

228 VI. Copper; *Cuprum, Venus, Ær.*

This metal is,

- a. Of a red colour.
- b. The specific gravity of the Japan copper is 9000, and of the Swedish 8784 or 8843 to 1000.

c. It is pretty soft and tough.

d. The calx of copper being dissolved by acids becomes green, and by alkalis blue.

e. It is easily calcined in the fire into a blackish blue substance, which, when rubbed to a fine powder, is red; when melted together with glass, it tinges it first reddish brown, and afterwards of a transparent green or sea-green colour.

f. It dissolves in all the acids; viz. the acids of vitriol, sea-salt, nitre, and the vegetable; and likewise in all alkaline solutions. That it becomes rusty, and tarnishes in the air (a consequence of a former solution), depends very much on some vitriolic acid which is left in the copper in the refining of it. This metal is easier dissolved when in form of a calx than in a metallic state, especially by the acids of vitriol and sea-salt, and the vegetable acid.

g. Vitriol of copper is of a deep blue colour; but the vegetable acid produces with the copper a green salt, which is verdigrise.

h. It can be precipitated out of the solutions in a metallic state; and this is the origin of the precipitated copper of the mines, called *Ziment copper*.

i. It is not easily amalgamated with quicksilver; but requires for this purpose a very strong trituration, or the admixture of the acid of nitre.

k. It becomes yellow when mixed with zinc, which has a strong attraction to it, and makes brass, pinchbeck, &c.

l. It is easily dissolved by lead glass, which last is coloured green by it.

m. When this metal is exposed to the fire, it gives a green colour to the flame in the moment it begins to melt, and continues to do so

afterwards, without losing any thing considerable of its weight.

n. It requires a strong degree of heat before it melts, yet is it a lesser degree than for iron.

Copper is found in the earth,

A. Native, or in a metallic state; virgin or native copper.

1. Solid, is found in the iron mine of Heflslekulla in the province of Nerike, and at Sunnerskog in the province of Smaoland; also in the Russian Carelia, and in other foreign places.

2. Friable, in form of small, and somewhat coherent grains. Precipitated or ziment copper. It is found at Ridderhyttan in Westmanland, at Fahln in Dalarn, and in Hungary.

It has been observed, that both copper and silver glass ore, being precipitated from water, become friable and granulated, but that they in time grow solid and ductile: whence the dispute about the distinction between native and precipitated copper may cease; the rather as native copper will scarcely be found in other places, and in any other kinds of stones, than those thro' which the ziment or vitriolic waters have circulated; although the fissures through which it has run may afterwards be filled with a stony substance.

B. In form of a calx.

(1.) Pure.

A. Loose or friable; *Ochra veneris*.

1. Blue; *Ceruleum montanum*. Is very seldom found perfectly free from a calcareous substance.

2. Green; *Viride montanum*. Both these colours depend on menstrua, which often areedulcorated or washed away.

3. Red. This is an efflorescence of the glass copper ore. It is found in the province of Dal, and at Ostanberg in the province of Dalarn.

b. Indurated. Glass copper ore.

a. Red. This is sometimes as red as sealing-wax, and sometimes of a more liver-brown colour. It is found in Sandbacken, at Norberg in Westmanland, at Ordal in Norway, in Siberia, and in Suabia in Germany.

This ore is always found along with native copper, and seems to have lost its phlogiston by way of efflorescence, and to be changed into this form. It is likewise found along with the sulphurated copper; and is commonly, though very improperly, called *glass copper ore*.

(2.) Mixed.

A. Loose or friable; *Ochra veneris friabilis impura*.

1. Mixed with a calcareous substance; *Ceruleum montanum*. In this state copper blue is mostly found. It ferments during the solution in aquafortis.

2. Mixed with iron. Black. It is the decom-

True  
METALS.  
Copper.

decomposition of the Falun copper ore.

b. Indurated.

1. Mixed with gypsum, or plaster. Green. Is found at Ordal in Norway, and there called *malachites*.
2. Mixed with quartz. Red. From Sunnerkog in the province of Smoland.
3. Mixed with lime. Blue. This is the *lapis armenus*, according to the accounts given of it by authors.

C. Dissolved and mineralised; *Cuprum mineralifatum*.

(1.) With sulphur alone. Grey copper ore. Is improperly also called *glafs copper ore*.

a. Solid, without any certain texture. This is very soft, so that it can be cut with a knife, almost as easily as black lead.

b. Fine-cubical; *Minera cupri sulphurata tessilis confians minoribus*. Both these varieties are found at Sunnerkog in Smoland; where the last is sometimes found decomposed or weathered, and changed into a deep mountain blue.

(2.) With sulphurated iron. *Minera cupri pyritacea*; yellow copper ore. Marcasitical copper ore; *Pyrites cupri*. This is various both in regard to colour, and in regard to the different proportion of each of the contained metals; for instance,

a. Blackish grey, inclining a little to yellow; *Pyrites cupri griseus*. When decayed or weathered, it is of a black colour; is the richest of all the varieties of this kind of copper ore, yielding between 50 and 60 per cent. and is found in Spain and Germany.

b. Reddish yellow, or liver brown, with a blue coat on the surface; *Minera cupri lazurea*. This ore yields between 40 and 50 per cent. of copper, and is commonly said to be blue, though it is as red, when fresh broke, as a red copper regulus.

c. Yellowish green; *Pyrites cupri flavo viridescens*. This is the most common in the north part of Europe; and is, in regard to its texture, found,

1. Solid, and of a shining texture, from Ostanberg in the province of Dalarne.
2. Steel-grained, of a dim texture, from the same place, and Falun in Dalarne.
3. Coarse-grained, is of an uneven and shining texture. It occurs in most of the Swedish and Norwegian copper mines.

4. Crystallised marcasitical copper ore.

a. Of long octoedric crystals. This is found at Hevasswik in the province of Dal, and in Lovisagrufva in Westmanland; notwithstanding its existence is denied by Henckel and his followers.

d. Pale yellow. This cannot be described but as a marcasite, though an experienced eye will easily discover some difference be-

tween them. It yields 22 per cent. of True copper.

True  
METALS.  
Iron.

e. Liver-coloured. This is found at Falun, in Dalarne in Sweden, where it contains copper; though at most other places where it occurs, it does not contain any copper, but is only a martial marcasite.

(3.) With sulphurated arsenic and iron. White copper ore. It is said to be found in the Hartz in Germany, and to resemble an arsenical pyrites; but most of the pyritical copper ores, as well as the marcasites, contain a little arsenic, though it is in too small a quantity to be observable.

(4.) Dissolved by the vitriolic acid; *Vitriolau veneris*. 236

(5.) With phlogiston. Copper coal-ore.

VII. Iron; *Ferrum, Mars*. It is, 237

a. Of a blackish blue shining colour.

b. It becomes ductile by repeated heating between coals, and hammering.

c. It is attracted by the loadstone, which is an iron ore; and the metal itself may also be rendered magnetical.

d. Its specific gravity to water is as 7,645, or 8000 : 1000.

e. It calcines easily to a black scaly calx, which, when powdered, is of a deep red colour.

f. When this calx is melted in great quantity with glass compositions, it gives a blackish brown colour to the glass; but in a small quantity a greenish colour, which at last vanishes, if forced by a strong degree of heat.

g. It is dissolved by all salts, by water, and likewise by their vapours. The calx of iron is dissolved by the spirit of sea-salt, and by aqua regia.

h. The calx of the dissolved metal becomes yellow, or yellowish brown; and in a certain degree of heat, it turns red.

i. The same calx, when precipitated from acids by means of the fixed alkali, is of a greenish colour; but it becomes blue, when precipitated by means of an alkali united with phlogiston; in which last circumstance the phlogiston unites with the iron: these two precipitates lose their colour in the fire, and turn brown.

k. The vitriol of iron is brown.

l. It is the most common metal in nature, and at the same time the most useful in common life; notwithstanding which, its qualities are perhaps very little known.

Iron is found, 238

A. In form of calx.

[1.] Pure.

a. Loose and friable. Martial ochre; *Minera ochracea*.

1. Powdery; *Ochra ferri*. This is commonly yellow or red, and is iron which has been dissolved by the vitriolic acid.

2. Concreted. Bog-ore.

a. In form of round porous balls.

b. More solid balls.

c. In small flat pieces, like cakes, or pieces of money.

- d.* In small grains.  
*e.* In lumps of an indeterminate figure. All these are of a blackish brown, or a light brown colour.
- B.** Indurated. The bloodstone; *Hematites*.  
 (1.) Of an iron colour; *Hematites cærulefcens*. This is of a blueish grey colour; it is not attracted by the loadstone, yields a red powder when rubbed, and is hard.  
*a.* Solid, and of a dim appearance when broken.  
*b.* Cubical, and of a shining appearance when broken.  
*c.* Fibrous, is the most common *torrefcens* of Sweden.  
*d.* Scaly; the *eifenman* of the Germans.  
 1. Black; from Gellebeck, in Norway.  
 2. Blueish grey; from Reka Klitt. When this is found along with marcasite, as at Sandfwar in Norway, it is not only attracted by the loadstone, but is of itself really a loadstone.  
*e.* Crystallised.  
 1. In octoëdric crystals.  
 2. In polyëdric crystals.  
 3. In a cellular form. These varieties are the most common in Sweden, and are very seldom blended with marcasite, or any other heterogeneous substance, except their different beds. It is remarkable, that, when these ores are found along with marcasite, those particles which have lain nearest to the marcasite are attracted by the loadstone, although they yield a red, or reddish brown powder, like those which are not attracted by the loadstone: it is likewise worth observation, that they generally contain a little sulphur, if they are imbedded in a lime-stone rock, which, however, very seldom happens in Sweden; but there is one such instance at Billfia in Soderberke, in the province of Dalarna.
- 240 (2.) Blackish brown bloodstone; *Hematites nigrefcens*. Kidney ore. This yields a red or brown powder when it is rubbed; it is very hard, and is attracted by the loadstone.  
*a.* Solid, with a glassy texture.  
*b.* Radiated.  
*c.* Crystallised.  
 1. In form of cones, from Siberia.  
 2. In form of concentric balls, with a faceted surface. These are very common in Germany, but very scarce in Sweden.
- 241 (3.) Red bloodstone; *Hematites ruber*. Red kidney ore.  
*a.* Solid, and dim in its texture.  
*b.* Scaly. The *eifenman* of the Germans. This is commonly found along with the iron-coloured iron glimmer, and smears the hands.  
*c.* Crystallised, in concentric balls, with a flat or faceted surface.  
 (4.) Yellow bloodstone; *Hematites flavus*.  
*a.* Solid.  
*b.* Fibrous, from Lamerhof in Bohemia. The varieties of the colours in the bloodstone are the same with those produced in the calces of iron, made by dry or liquid menstrua, and afterwards exposed to different degrees of heat.
- [2.] Iron in form of calx, mixed with heterogeneous substances.  
 243 *a.* With a calcareous earth. White spathose iron ore. The *stahlstein* of the Germans.  
*b.* With a siliceous earth. The martial jasper of Sinople.  
*c.* With a garnet earth. Garnet and cockle or shirl.  
*d.* With an argillaceous earth. The bole.  
*e.* With a micaceous earth. Mica.  
*f.* With manganese.  
*g.* With an alkali and phlogiston. Blue martial earth. Native Prussian-like blue.  
 244 1. Loose or powdery; found among the turf in the levels of the province of Skone; also in Sax Weiffenfels, and at Norvlanden in Norway, &c.  
*h.* With an unknown earth, which hardens in water. Tarras; *Cementum*.  
 245 1. Loose or granulated; *Terra Puzzolana*: from Naples and Civita Vecchia in Italy. This is of a reddish brown colour, is rich in iron, and is pretty fusible.  
 2. Indurated; *Cementum induratum*. This is of a whitish yellow colour, contains likewise a great deal of iron, and has the same quality with the former, to harden soon in water, when mixed with mortar. This quality cannot be owing to the iron alone, but rather to some particular modification of it occasioned by some accidental causes, because these varieties rarely happen at any other places except where volcanos have been, or are yet in the neighbourhood.
- 247 1. Calx of iron, united with another unknown earth. The *tungsten* of the Swedes. This is also, though improperly, called *white tin-grains*. This resembles the garnet-stone, and the tin-grains; is nearly as heavy as pure tin; very refractory in the fire, and excessively difficult to reduce to metal. Iron has, however, been melted out of it to more than 30 per cent. It is very difficultly dissolved by borax and alkaline salts, but melts very easily with the microcosmic salt; giving a black slag; and for this reason, this last mentioned salt must be



be employed in the experiments on this stone. It is found,

1. Solid and fine-grained.
  - a. Reddish or flesh-coloured.
  - b. Yellow.
2. Spathose, and with an unctuous surface.

a. White.  
 b. Pearl-coloured. This kind of stone is very seldom met with, but in such places where black-lead is common in the neighbourhood; and the history of the black lead, inserted in the Memoirs of the Swedish Academy of Sciences, gives reason to believe, that this may contain some tin; which merits further examination. Mr Cronstedt has in the said Memoirs communicated his experiments upon this kind of stone from Riddarshyttan, and Bisfberget in Westmanland; as has also Mr Rinman, on a great number of other martial earths. See the Memoirs for the years 1751 and 1754.

B. Dissolved or mineralised iron.

- [1.] With sulphur alone.
  - a. Perfectly saturated with sulphur; *Ferrum sulphure saturatum*. Marcasite.
  - b. With very little sulphur. Black iron ore. Iron stone.

This is either attracted by the loadstone, or is a loadstone itself attracting iron; it resembles iron, and yields a black powder when rubbed.

- (1.) Magnetic iron ore. The loadstone, *Magnes*.

- a. Steel-grained, of a dim texture, from Hogberget in the parish of Gagnef in Dalarna: it is found at that place almost to the day, and is of as great strength as any natural loadstones were ever commonly found.
- b. Fine grained, from Saxony.
- c. Coarse-grained, from Spetalsgrufvan at Norberg, and Kierrgrufvan, both in the province of Westmanland. This loses very soon its magnetical virtue.
- d. With coarse scales, found at Sandfwer in Norway. This yields a red powder when rubbed.

- (2.) Refractory iron ore. This in its crude state is attracted by the loadstone.

- a. Giving a black powder when rubbed; *Tritura atra*. Of this kind are,
  1. Steel-grained.
  2. Fine-grained.
  3. Coarse-grained. This kind is found in great quantities in all the Swedish iron mines; and of this most part of the fusible ores consist, because it is commonly found in such kinds of rocks as are very

fusible: and it is as seldom met with in quartz as the hæmatites is met with in limestone.

- b. Rubbing into a red powder. These are real hæmatites, that are so far modified by sulphur or lime as to be attracted by the loadstone.

1. Steel-grained.
2. Fine-grained. Emery. This is imported from the Levant: it is mixed with mica, is strongly attracted by the loadstone, and smells of sulphur when put to the fire.
3. Of large shining cubes.
4. Coarse, scaly. The *eisenglimmer* or *eisenman*, from Gellebeck in Norway.

These are very scarce in Sweden, most part of the Swedish bloodstones being pure, as has already been said, and form that very profitable ore in Swedish called *torsten*.

- [2.] With arsenic; *Ferrum arsenico mineralisatum*. Called *nispickel* by the Germans, and *plate mundic* in Cornwall.

- [3.] With sulphurated arsenic. Arsenical pyrites.

- [4.] With vitriolic acid. Martial vitriol.

- [5.] With phlogiston. Martial coal ore.

- [6.] With other sulphurated and arsenicated metals. See these in their respective arrangements.

SECOND ORDER. Semi-metals.

There are but seven semi-metals yet discovered, viz.

- I. Quicksilver, mercury; *Argentum vivum*, *mercurius*, *hydrargyrum*.

This distinguishes itself from all metals, by the following qualities:

- a. Its colour is white and shining, a little darker than that of silver.
- b. It is fluid in the cold, and divisible by the least force; but as it only sticks to a few bodies, to which it has an attraction, it is said that it does not wet.
- c. It is volatile in the fire.
- d. Its weight is next to that of the gold, viz. to water, as 13,593 : : 1000.
- e. It attracts the other semi-metals and metals, and unites with them all, except cobalt and nickel, with which it cannot by any means yet known be made to mix. This union is called an *amalgamation*. This amalgamation, or mixture of metallic bodies, according to the readiness with which they unite or mix, is in the following progression, viz. gold, silver, lead, tin, zinc, bismuth, copper, iron, and the regulus of antimony: but the three latter, however, do not very readily amalgamate. The iron requires a solution of the vitriol of iron, as a medium to promote the union.

- f. It dissolves in the spirit of nitre, out of which it is precipitated by a volatile alkali, and the common salt, in form of a white powder; but

if a fixed alkali is used, into a yellow powder or calx.

- g. It dissolves in the oil of vitriol by a strong boiling.
- h. It is not affected by the acid of common salt, unless it be previously dissolved by other acids; in which case only they unite with one another, and may be sublimed together, which sublimation is a strong poison.
- i. It unites with sulphur by grinding; and then produces a black powder called *athrops mineralis*, which sublimes into a red striated body called *fuliginous cinnabar*.
- k. The sulphur is again separated from the quicksilver, by adding iron or lime, to which the sulphur attaches itself, leaving the quicksilver to be distilled over in a metallic form; but if a fixed alkali is added to it, some part of the quicksilver will remain in the residuum, and in that case makes a liver of sulphur.

252

Quicksilver is found,

A. Native, or in a metallic state. This is found in the quicksilver mines at Idria in Friuli, or the Lower Austria, in clay, or in a black slaty lapis ollaris, out of which it runs, either spontaneously or by being warmed even in the hands. It has several times been found at Herr Sten's Bottin, in the mines of Salberg in Westmanland, and sometimes also amalgamated with native silver.

253

B. Mineralised,

(1.) With sulphur. *Cinnabar*; *Cinnabaris nativa*. This is of a red colour, and its specific gravity to water is as 7500 to 10000.

a. Loose or friable cinnabar; looks like red ochre.

b. Indurated. Solid cinnabar. Is of a deep red colour; and, with respect to its texture, is either,

1. Steel-grained:
2. Radiated:
3. Composed of small cubes, or scaly:
4. Chrytalised,

a. In a cubical form; it is transparent, and deep red as a ruby.

254

(2.) With sulphur and copper; *Mercurius cupro sulphurato mineralisatus*. This is blackish grey, of a glassy texture, and brittle; cracks and splits excessively in the fire; and when the quicksilver and sulphur are evaporated, the copper is discovered by its common opaque red colour in the glass of borax, which, when farther forced in the fire, or diluted, becomes green and transparent.

255

II. Bismuth; tin-glass. *Vismutum, bismutum, marcassita officinalis*. It is,

a. Of a whitish yellow colour.

b. Of a laminated texture, soft under the hammer, and nevertheless very brittle.

c. Its specific gravity to water is, as 9,700 : 1000.

d. It is very fusible; calcines and scorifies like lead, if not rather easier; and therefore it works on the cuppel. It is pretty volatile in the fire.

e. Its glass or slag becomes yellowish brown, and has the quality of retaining some part of the

gold, if that metal has been melted, calcined, and vitrified with it.

f. It may be mixed with the other metals, except cobalt and zinc, making them white and brittle.

g. It dissolves in aquafortis, without imparting to it any colour; but to the aqua-regia it gives a red colour, and may be precipitated out of both these solutions with pure water, into a white powder, which is called *Spanish white*. It is also precipitated by the acid of sea-salt; which last unites with it, and makes the *vismutum corneum*.

h. It amalgamates easily with quicksilver. Other metals are so far attenuated by the bismuth, when mixed with it, as to be strained or forced along with the quicksilver through skins or leather.

Bismuth is found in the earth.

256

A. Native. This resembles a regulus of bismuth, but consists of smaller scales or plates.

1. Superficial, or in crústs.

2. Solid, and composed of small cubes. This is found in and with the cobalt ore, at Schneeberg in Saxony, and other foreign places; likewise along with the copper ore, at Nyberget, in the parish of Stora Skedwi, in the province of Dalarna.

B. In form of calx.

1. Powdery or friable; *Ochra vismuti*. This is of a whitish yellow colour; it is found in form of an efflorescence, to the day, at Los in the province of Helplingland.

257

It has been customary to give the name of *flowers of bismuth* to the pale red calx of cobalt, but it is wrong; because neither the calx of bismuth, nor its solutions, become red, this being a quality belonging to the cobalt.

C. Mineralised bismuth. This is, with respect to colour and appearance, like the coarse tessellated potter's lead ore; but it consists of very thin square plates or flakes, from which it receives a radiated appearance when broken crosswise.

258

1. With sulphur.

a. With large plates or flakes, from Bastnas at Riddarhyttan, Bafringe and Straps in Westmanland.

b. With fine or small scales, from Jacobsgruvan at Riddarhyttan, and the mines at Los in the parish of Farila in Helplingland.

2. With sulphurated iron.

a. Of coarse, wedge-like scales, from Kongruben, at Gellebeck in Norway.

This mineralised bismuth ore yields a fine radiated regulus; for which reason it has been ranked among the antimonial ores, by those who have not taken proper care to melt a pure regulus or destitute of sulphur from it; while others, who make no difference between regulus and pure metals, have still more positively asserted it to be only an antimonial ore.

III. Zinc; speltre. *Zincum*.

259

a. Its colour comes nearest to that of lead, but it does not so easily tarnish.

b. It shows a texture, when it is broken, as if it were compounded of flat pyramids.

c. Its

- c. Its specific gravity to water is, as 6,900 or 7000 to 10000.
- d. It melts in the fire before it has acquired a glowing heat; but when it has gained that degree of heat, it burns with a flame of a changeable colour, between blue and yellow; and if in an open fire, the calx rises in form of soft white flowers; but if in a covered vessel, with the addition of some inflammable, it is distilled in a metallic form; in which operation, however, part of it is sometimes found vitrified.
- e. It unites with all the metals, except bismuth, and makes them volatile. It is, however, not easy to unite it with iron without the addition of sulphur. It has the strongest attraction to gold and copper, and this last metal acquires a yellow colour by it; which has occasioned many experiments to be made to produce new metallic compositions.
- f. It is dissolved by all the acids: of these the vitriolic acid has the strongest attraction to it; yet it does not dissolve it, if it is not previously diluted with much water. The abundance of phlogiston in this semi-metal is perhaps the reason of its strong attraction to the vitriolic acid.
- g. Quicksilver amalgamates easier with zinc than with copper, by which means it is separated from compositions made with copper.
- h. It seems to become electrical by friction, and then its smaller particles are attracted by the loadstone; which effects are not yet perfectly investigated; but they may excite philosophers to make farther experiments, in order to discover whether the electrical power shews itself in the metals by being attracted by the loadstone, or whether the magnetic power can be exerted on other metals than iron.

Zinc is found,

A. In form of calx.

(1.) Pure.

a. Indurated.

1. Solid.

2. Crystallised.

This is of a whitish grey colour, and its external appearance is like that of a lead spar; it cannot be described, but is easily known by an experienced eye. It looks very like an artificial glass of zinc; and is found among other calamines at Namur, and in England.

(2.) Mixed.

A. With a martial ochre; *Ochra fere calx zinci martialis*.

1. Half indurated. Calamine; *Lapis laminaris*.

a. Whitish yellow,

b. Reddish brown.

This seems to be a mouldered or weathered blende.

b. With a martial clay or bole.

c. With a lead ochre and iron.

B. Mineralised zinc.

(1.) With sulphurated iron. Blende, mock-lead, black-jack, mock-ore; *Pseudogalena* and blende of the Germans.

A. Mineralised zinc in a metallic form. Zinc ore.

This is of a metallic blueish grey colour, neither perfectly clear as a potter's ore, nor so dark as the Swedish iron ores.

1. Of a fine cubical or scaly texture.

2. Steel-grained.

2. In form of calx. Blende. Mock-lead; 262  
*Sterile nigraum. Pseudogalena*. This is found,

1. With coarse scales,

a. Yellow; semi-transparent.

b. Greenish.

c. Black; *peckblende* or *pitch blende* of the Germans.

d. Blackish brown.

2. With fine scales,

a. White.

b. Whitish yellow.

c. Reddish brown.

3. Fine and sparkling; at Goslar called *braun bleyertz*.

a. Dark brown.

The zinc, in these last kinds of blendes, is as it were in form of a calx or glass, so that they are often transparent: on the contrary, in the zinc ore, (n<sup>o</sup> 261.) it seems rather to be in a metallic form, or, like most other metals, mineralised with sulphur. The sulphur, nevertheless, exists in the different kinds of blende, equally as in the zinc ore; and this remarkable difference in their appearance must be accounted for from another principle than the quantity of the zinc which they contain; because the yellow and white blendes are often found richer than the zinc ores; but the zinc ores are, however, more easy to melt, and consequently more profitable. Perhaps it is because the blende does not contain a sufficient quantity of the phlogiston of the sulphur, to prevent the calcination of the zinc.

It is no matter whether a calcined blende is called *calamine* or not, provided it has such properties that it may be employed to the same purposes, and with the same advantage, as that calamine which nature has freed from its sulphur by its weathering or decaying. This may be done with some kinds of blende; and Mr Von Swab has given evident and excellent proofs of it in Sweden; inasmuch that it would demonstrate a want of experience to insist that sulphur cannot be expelled by calcination, without destroying the zinc itself, and that flowers of zinc may be produced from zinc ores in a calcining heat, without addition of any phlogiston.

Mr

Mr Justi however avers, that he has found an ore of this quality, which in his Mineralogy he calls *Zinkspat*: but there is great reason to doubt if it really contains any zinc, until it is proved whether the author added any phlogiston during the calcination, or reduced the zinc out of it; because, although the flowers of zink may not always be perfectly well calcined, yet there is no instance of a natural zinc ore being discovered, which by itself yields those flowers during the calcination: and it requires, besides, a strong heat to produce these flowers from a perfect calx or glass of this semi-metal, either natural or artificial, though mixed with a phlogiston; for it could not have been a native zinc, since it resembled a spar, and such a one very likely is not to be found in nature.

stone; since, according to Mr Pott's experiments, an artificial regulus of antimony may, by means of lime, be disposed to an amalgamation: Secondly, That when brought in form of a calx, it shot into crystals during the cooling.

B. Mineralised antimony.

(1.) With sulphur.

This is commonly of a radiated texture, composed of long wedge-like flakes or plates; it is nearly of a lead colour, and rough to the touch.

a. Of coarse fibres.

b. Of small fibres.

c. Steel-grained, from Saxony and Hungary.

d. Crystallified, from Hungary.

1. Of a prismatical, or of a pointed pyramidal figure, in which last circumstance the points are concentrical.

Mr Cronstedt mentions a specimen of this, in which the crystals were covered with very minute crystals of quartz, except at the extremities, where there was always a little hole: this specimen was given for a *flor ferri* spar.

(2.) With sulphur and arsenic. Red antimony ore; *Antimonium fulvum*.

This is of a red colour, and has the same texture with the preceding, though its fibres are not so coarse.

a. With small fibres.

b. With abrupt broken fibres, from Braunsdorf in Saxony, and from Hungary.

All antimonial ores are somewhat arsenical, but this is more so than the preceding kinds.

(3.) With sulphurated silver. Plumose silver-ore.

(4.) With sulphurated silver, copper, and arsenic.

(5.) With sulphurated lead.

V. Arsenic. This is,

a. In its metallic form, nearly of the same colour as lead, but brittle, and changes sooner its shining colour in the air, first to yellow, and afterwards to black.

b. It appears laminated in its fractures, or where broken.

c. Is very volatile in the fire, burns with a small flame, and gives a very disagreeable smell like garlic.

d. It is, by reason of its volatility, very difficult to be reduced, unless it is mixed with other metals: However, a regulus may be got from the white arsenic, if it is quickly melted with equal parts of pot-ashes and soap; but this regulus contains generally some cobalt, most of the white arsenic being produced from the cobalt ores during their calcination. The white arsenic, mixed with a phlogiston, sublimes likewise into octoedral crystals of a metallic appearance, whose specific gravity is 8,308.

e. The calx of arsenic, which always, on account of

263

IV. Antimony; *Antimonium Sibiricum*. This semi-metal is,

a. Of a white colour almost like silver.

b. Brittle; and in regard to its texture, it consists of shining planes, of greater length than breadth.

c. In the fire it is volatile, and volatilises part of the other metals along with it, except gold and platina. It may, however, in a moderate fire, be calcined into a light grey calx, which is pretty refractory in the fire, but melts at last to a glass of a reddish brown colour.

d. It dissolves in spirit of sea-salt and aqua regia, but is only corroded by the spirit of nitre into a white calx; it is precipitated out of the aqua regia by water.

e. It has an emetic quality when its calx, glass, or metal, is dissolved in an acid, except when in the spirit of nitre, which has not this effect.

f. It amalgamates with quicksilver, if the regulus, when fused, is put to it; but the quicksilver ought for this purpose to be covered with warm water: it amalgamates with it likewise, if the regulus of antimony be previously melted with an addition of lime.

Antimony is found in the earth.

A. Native.

This is of a silver colour, and its texture is composed of pretty large shining planes.

This kind was found in Carls Ort, in the mine of Salberg, about the end of the last century; and specimens thereof have been preserved in collections under the name of an arsenical pyrites, until the mine-master Mr Von Swab discovered its real nature, in a treatise he communicated to the Royal Academy of Sciences at Stockholm in the year 1748. Among other remarkable observations in this treatise, it is said, first, That this native antimony easily amalgamated with quicksilver; doubtless, because it was imbedded in a lime-

264

265

266

267

of its volatility, must be got as a sublimation, is white, and easily melts to a glass, whose specific gravity is 5,000. When sulphur is blended in this calx, it becomes of a yellow, orange, or red colour; and according to the degrees of colour is called *orpiment* or yellow arsenic; *sandarach*, *realgar*, or red arsenic; and also *rubinus arsenici*.

- f. This calx and glass are dissoluble in water, and in all liquids; though not in all with the same facility. In this circumstance arsenic resembles the salts; for which reason it also might be ranked in that class.
- g. The regulus of arsenic dissolves in spirit of nitre; but as it is very difficult to have it perfectly free from other metals, it is yet very little examined in various menstrua.
- h. It is poisonous, especially in form of a pure calx or glass: But probably it is less dangerous when mixed with sulphur, since it is proved by experience, that the men at mineral works are not so much affected by the smoke of this mixture as by the smoke of lead; and that some certain nations make use of the red arsenic in small doses as a medicine.
- i. It unites with all metals, and is likewise much used by nature itself to dissolve, or, as we term it, to *mineralise*, the metals, to which its volatility and dissolubility in water must greatly contribute. It is likewise most generally mixed with sulphur.
- k. It absorbs or expels the phlogiston, which has coloured glasses, if mixed with them in the fire.

Arjenic is found,  
[1.] Native; called *Scherbencobolt* and *Fliegenstein* by the Germans.

It is of a lead colour when fresh broken, and may be cut with a knife, like black lead, but soon blackens in the air. It burns with a small flame, and goes off in smoke.

A. Solid and testaceous.

This is found in the mines of Saxony, the Hartz, and Hungary.

B. Scaly, at Kongberg in Norway.

C. Friable and porous; *Fliegenstein*.

(1.) With shining fissures.

This is by some called *Spigel cobolt*, (*minera cobaltii specularis*), according to their notions of the affinity of these metals to one another. However, there always remains after the volatilisation of the *Scherbencobolt*, some calx, either of cobalt or bismuth, and some flue, though in too small a quantity to deserve any notice.

(2.) In form of a calx.

A. Pure, or free from heterogeneous substances.

1. Loose or powdery.

2. Indurated, or hardened. This is found in form of white semi-transparent crystals.

B. Mixed with sulphur.

1. Hardened.

a. Yellow. Orpiment; *Auripigmentum*.

b. Red. Native realgar, or sandarach.

The orpiment may perhaps be found

naturally in loose scaly powder, as it is sometimes met with in the shops: however, the hardened sort is seldom found but in collections.

- C. Mixed with the calx of tin, in the tin-grains.  
D. With sulphur and silver, in the rothgalden, or red silver ore.  
E. With calx of lead, in the lead-spar.  
F. With calx of cobalt, in the efflorescence of cobalt.

[2.] Mineralised.

A. With sulphur and iron. Arsenical pyrites or marcasite. These kinds in Cornwall are called *filvery* or *white mundics*, and *plate mundics*.

269

This alone produces red arsenic, when calcined, and is found in great quantities in the mines of Loras in the province of Dalarnae: It is of a deeper colour than the following.

B. With iron only. This differs with regard to its particles, being,

1. Steel-grained;
2. Coarse-grained, from *Westerfällsverberget*;
3. Crystallised.

a. In an octoëdral figure. This is the most common kind.

b. Prismatical. The sulphureous marcasite is added to this kind, when red arsenic is to be made; but in Sweden it is scarcer than the sulphureous arsenical pyrites.

C. With cobalt, almost in all cobalt ores.

D. With silver.

E. With copper.

F. With antimony.

VI. Cobalt.

This semi-metal is,

270

A. Of a whitish grey colour, nearly as fine-tempored steel.

b. Is hard and brittle, and of a fine-grained texture; hence it is of a dusky, or not shining appearance.

c. Its specific gravity to water is 6000 to 1000.

d. It is fixt in the fire, and becomes blue by calcination; it then gives to glasses a black colour, inclining a little to violet, which colour, of all others, is the most fixed in fire.

e. The concentrated oil of vitriol, aquafortis, and aqua-regia, dissolve it; and the solutions become red. The cobalt calx is likewise dissolved by the same menstrua, and also by the volatile alkali and the spirit of sea-salt.

f. When united with the calx of arsenic in a flow (not a brisk) calcining heat, it assumes a red colour: the same colour is naturally produced by way of efflorescence, and is then called the *blooms*, or *flowers of cobalt*. When cobalt and arsenic are melted together in an open fire, they produce a blue flame.

g. It does not amalgamate with quicksilver by any means hitherto known.

h. Nor does it mix with bismuth, when melted with it, without addition of some medium to promote their union.

The cobalt is most commonly found in the earth mixed with iron.

A. In form of a calx.

- (1.) With iron without arsenic.  
 a. Loose or friable. Cobalt ochre. It is black, and like the artificial zaffre.  
 b. Indurated; the *schlacken* or slag cobalt. This is likewise of a black colour, but of a glassy texture; and seems to have lost that substance which mineralised it, by being decayed or weathered. It is often confounded with the *scherbencobolt*, for it is seldom quite free from arsenic; and there may perhaps exist a progressive series from the *schlacken* kind to the *scherbencobolt* kind.

272

(2.) With the calx of arsenic. Cobalt-blut; *Ochra cobaltii rubra*; bloom, flowers, or efflorescence, of cobalt.

- a. Loose or friable. This is often found of a red colour like other earths, spread very thin on the cobalt ores, and is, when of a pale colour, erroneously called *flowers of bisnuth*.  
 b. Indurated. Hardened flowers of cobalt. This is commonly crystallised in form of deep red semi-transparent rays or radiations.

A white cobalt-earth, or ochre, is said to have been found. It has been seen and examined by a celebrated mineralist, who has found it in every respect, except the colour, to resemble the cobalt flowers; and it is very possible that those cobalt flowers might in length of time have lost their red colour, and become white.

273

B. Mineralised.

- (1.) With arsenic and iron in a metallic form. This is of a dim colour when broken, and not unlike steel. It is found,  
 a. Steel-grained.  
 b. Fine-grained,  
 c. Coarse-grained.  
 d. Crystallised.  
 1. In a dendritical or arborescent form.  
 2. Polyëdral, with shining surfaces; the *glanzkobolt* of the Germans.  
 3. In radiated nodules.

274

(2.) With sulphurated iron. This is of a lighter colour than the preceding, nearly like to tin or silver. It is found,

- a. Crystallised.  
 1. In a polygonal form.  
 a. Of a sluggy texture.  
 b. Coarse-grained. This kind discovers not the least mark of arsenic. The coarse-grained becomes slimy in the fire, and sticks to the stirring hook during the calcination, in the same manner as many regulæ do; and is a kind of regulæ prepared by nature.

That sort of a sluggy texture is very martial, and is described by the mine-master Mr Brandt, in the *Actis* of the Swedish Academy of Sciences for the year 1746. Both these give a beautiful colour.

275

(3.) With sulphur, arsenic, and iron. This re-

sembles the arsenicated cobalt ore, being only rather of a whiter or lighter colour. It is found,

- a. Coarse-grained.  
 b. Crystallised,

1. In a polygonal figure, with shining surfaces, or *glanzkobolt*. It is partly of a white or light colour, and partly of a somewhat reddish yellow.

(4.) With sulphurated and arsenicated nickel and iron; see n<sup>o</sup> 279.

276

VII. Nickel; *Niccolum*. This is the latest discovered semi-metal. It was first described by its discoverer Mr Cronstedt, in the *Actis* of the Royal Academy of Sciences at Stockholm for the years 1751 and 1754, where it is said to have the following qualities: That,

277

1. It is of a white colour, which, however, inclines somewhat to red.  
 2. Of a solid texture, and shining in its fractures.  
 3. Its specific gravity to water is as 8,500 to 1000.  
 4. It is pretty fixt in the fire; but, together with the sulphur and arsenic, with which its ore abounds, it is so far volatile as to rise in form of hairs and branches, if in the calcination it is left without being stirred.  
 5. It calcines to a green calx.  
 6. This calx is not very fusible, but, however, tinges glass of a transparent reddish-brown or jacinth colour.  
 7. It dissolves in aquafortis, aqua regia, and the spirit of sea-salt, but more difficultly in the vitriolic acid, tinging all these solutions of a deep green colour. Its vitriol is of the same colour; but the colcothar of this vitriol, as well as the precipitates from the solutions, become by calcination of a light green colour.  
 8. These precipitates are dissolved by the spirit of sal ammoniac, and the solution has a blue colour; but being evaporated, and the sediment reduced, there is no copper, but a nickel regulus is produced.  
 9. It has a strong attraction to sulphur; so that when its calx is mixed with it, and put on a scorifying telt under the muffle, it forms with the sulphur a regulæ: this regulæ resembles the yellow steel-grained copper-ores, and is hard and shining on its convex surface.  
 10. It unites with all the metals, except quicksilver and silver. When the nickel regulus is melted with the latter, it only adheres close to it, both the metals lying near one another on the same plane; but they are easily separated with a hammer. Cobalt has the strongest attraction to nickel, after that to iron, and then to arsenic. The two former cannot be separated from one another but by their scorification; which is easily done, since  
 11. This semi-metal retains its phlogiston a long time in the fire, and its calx is reduced by the help of a very small portion of inflammable matter: it requires, however, a red heat before it can be brought into fusion, and melts a little sooner, or almost as soon as copper or gold, consequently sooner than iron.

The

Ophites,  
&c.Whetstones  
&c.

The nickel is found.

A. In form of a calx. Nickel ochre.

1. Mixed with the calx of iron. This is green, and is found in form of flowers on Kupfer-nickel.

B. Mineralised nickel.

1. With sulphurated and arsenicated iron and cobalt. *Kupfernickel*. This is of a reddish yellow colour; and is found,  
a. Of a flabby texture, in Saxony.  
b. Fine-grained; and

c. Scaly, in Loos cobalt-mines in the province of Helgingeland, at which place it is of a lighter colour than the foreign ones. These two are often from their colour confounded with the liver-coloured marcasite.

2. With the acid of vitriol. This is of a beautiful green colour, and may be extracted out of the nickel ochre, or efflorescence of the Kupfernickel.

*Of Saxa and Petrifications.*

281

THOUGH the *Saxa*, and fossils commonly called *petrifications*, cannot be ranked in a mineral system, as consisting of principles already taken notice of; yet as these bodies, especially the latter, occupy so considerable a place in most mineral collections, and the former must necessarily be taken notice of by the miners in the observations they make in the subterranean geography, it appeared proper to subjoin them in such an order as may answer the purpose for which they are regarded by miners and mineralogists.

## FIRST ORDER.

SAXA. *Petrae.*

282

These may be divided into two kinds.

1. Compound *saxa*, are stones whose particles, consisting of different substances, are so exactly fitted and joined together, that no empty space, or even cement, can be perceived between them; which seems to indicate, that some, if not all, of these substances have been soft at the instant of their union.

2. Conglutinated stones, are stones whose particles have been united by some cementitious substance, which, however, is seldom perceivable, and which often has not been sufficient to fill every space between the particles: in this case the particles seem to have been hard, worn off, and in loose, single, unfigured pieces, before they were united.

283

I. Compound *saxa*.A. *Ophites*. Scaly limestone with kernels or bits of serpentine stone in it.

1. *Kolmard's marble*. It is white and green.  
2. *Serpentino antico*, is white, with round pieces of black steatites in it. This must not be confounded with the *serpentino verde antico*.  
3. The *Haraldso marble*. White, with quadrangular pieces of a black steatites.

4. The *marmor pozzevera di Genova*. Dark green marble, with white veins. This kind receives its fine polish and appearance from the serpentine stone.

284

B. *Stellsten* or *gestellstein*; *Saxum compositum par-*  
VOL. VII.

2

*ticulis quartzosis & micaceis.*

1. Of distinct particles. In some of these the quartzose particles predominate, and in others the micaceous: in the last case it is commonly flaty, and easy to split.

2. Of particles which are wrapt up in one another.

a. Whitish grey.

b. Greenish.

c. Reddish. Both these kinds of *stellsten* are, for their resistance to the fire, employed in building furnaces; but the latter is the best, because it seems at the same time to contain a little of a refractory clayish substance: it, however, cracks very soon, if the flat side of the stratum, instead of the extremity, is turned towards the fire. It is also of great use in mills. It is lucky for economical purposes, that the plates of these stones are so thick, although thereby they are not so easily split.

C. *Norrka. Murksten* of the Swedes. *Saxum compositum micā, quartzo, et granato.* 285

1. With distinct garnets or shirl.

a. Light grey.

b. Dark grey.

c. Dark grey, with prismatical, radiated, or fibrous cockle or shirl.

2. With kernels of garnet-stone.

a. Of pale red garnet-stone. The first of this kind, whose flaty strata makes it commonly easy to be split, is employed for mill-stones, which without difficulty distinguish themselves for that purpose, if sand is first ground with them, because the sand wears away the micaceous particles on the surfaces, and leaves the garnets prominent, which renders the stone fitter for grinding the corn.

D. The whetstone, *Cor. Saxum compositum micā, quartzo, et forsan argillā martiali in nonnullis speciebus.* 286

1. Of coarse particles.

a. White.

b. Light grey.

2. Of fine particles.

a. Liver-brown colour.

b. Blackish grey.

c. Light grey.

d. Black. The table-slate, or that kind used for large tables and for school-slates.

The naked eye, and the magnifying glass, much better discovers the micaceous particles in this kind to be as it were twisted in one another; some clay seems likewise to enter into the composition: however, it cannot yet be certainly asserted that it is real mica which has that appearance in this kind.

3. Of very minute and closely combined particles. The Turkey stone. This is of an olive colour, and seems to be the finest mixture of the first species of this genus. It is found in loose stones at Biorckloginas in the parish of Hellefors in Westmanland, though

28 X

not

not perfectly free from cross veins of quartz, which always are in the surface of the rock, and spoil the whetstones. It is also said to be found in Tellemarken in Norway. The best of this sort come from the Levant, and are pretty dear. The whetstone kinds, when they split easily, and in thin plates, are very fit to cover houses with, tho' most of them are not used for that purpose.

E. The *teigsten* of the Swedes. *Lapis allaris*.

*Saxum compositum steatite et mica.*

a. Light grey.

b. Whitish yellow.

c. Dark grey.

d. Dark green. This is employed with great advantage to build fire-places and furnaces, &c. and when it is flaty, the extremities of the frata must be turned towards the fire.

287 F. Porphyry; *Porphyrites*. *Italorum porfido*.

*Saxum compositum jaspide et felspato, interdum mica et basalte.*

a. Its colour is green, with light green felspat, *Serpentino verde antico*. It is said to have been brought from Egypt to Rome, from which latter place the specimens of it now come.

b. Deep red, with white felspat.

c. Black, with white and red felspat.

d. Reddish brown, with light-red and white felspat.

e. Dark grey, with white grains of felspat also. Many varieties of this kind in regard to colour are found in form of nodules or loose stones in Sweden; but we have only mentioned the hardest and finest of those which are found in the rocks; because, besides these, there are coarse porphyries found, which scarce admit of any polish. The dark red porphyry has been most employed for ornaments in building; yet it is not the only one known by the name of *porfido*, the Italians applying the same name also to the black kind.

288 G. The *trapp* of the Swedes. *Saxum compositum jaspide martiali molli, seu argilla martiali indurata, et - - -*

This kind of stone sometimes constitutes or forms whole mountains; as, for example, the mountain called *Hunnberg* in the province of *Wettersgottland*, and at *Drammen* in Norway; but it is oftener found in form of veins in mountains of another kind, running commonly in a serpentine manner, contrary or across to the direction of the rock itself. It is not homogeneous, as may be plainly seen at those places where it is not pressed close together; but where it is pressed close, it seems to be perfectly free from heterogeneous substances. When this kind is very coarse, it is interspersed with felspat; but it is not known if the finer sorts likewise contain any of it. Besides this, there are also some fibrous particles in it, and something that resembles a calcareous spar; this, however, does not ferment with acids, but melts as easy as the stone itself, which be-

comes a black solid glass in the fire. By calcination it becomes red, and yields in effays 12 or more per cent. of iron. No other sort of ore is to be found in it, unless now and then somewhat merely superficial lies in its fissures; for this stone is commonly, even to a great depth in the rock, cracked in acute angles, or in form of large rhomboidal dice. It is employed at the glass-houses, and added to the composition of which bottles are made. By the Germans it is called *schwach* or *schwarzstein*; at the Swedish glass-works, *trappskiol*, *tegelkiol*, or *swartzkiol*; and at Jarlsberg in Norway, *blafest*. In the air it decays a little, leaving a powder of a brown colour; it cracks commonly in the fire, and becomes reddish brown if made red-hot. It is found,

1. Of coarse chaffy particles.

a. Dark grey.

b. Black.

2. Coarse-grained.

a. Dark grey.

b. Reddish.

c. Deep brown.

3. Of fine imperceptible particles.

a. Black. The touchstone; *Lapis hydius*.

b. Bluish.

c. Grey.

d. Reddish.

The black variety (3. a.) is sometimes found so compact and hard, as to take a polish like the black agate: it melts, however, in the fire to a black glass; and is, when calcined, attracted by the loadstone.

H. *Amygdaloides*. *Saxum basi jaspide martiali, cum fragmentis spati calcarei et serpentine, figura elliptica.* The carpolithi or fruit-stone rocks of the Germans. It is a martial jasper, in which elliptical kernels of calcareous spar and serpentine stone are included.

a. Red, with kernels of white limestone, and of a green steatite. This is of a particular appearance, and when calcined is attracted by the loadstone; it decays pretty much in the air, and has some affinity with the trapp, and also with the porphyry. There are sometimes found pieces of native copper in this stone.

I. The *gronsten* of the Swedes. *Saxum compositum mica et hornblende*. Its basis is hornblende, interspersed with mica. It is of a dark green colour, and is dug in several places in Smoland, where it is employed in the iron furnaces as a flux to the bog ore.

K. The granites. *Saxum compositum felspata, mica et quartzo, quibus accidentaliter interdum hornblende, steatites, granatus et basaltes immixti sunt.* Its principal constituent parts are felspat, or rhombic quartz, mica, and quartz.

It is found,

(1.) Loose or friable. This is used at the Swedish brass-works to cast the brass in, and comes from France.

(2.) Hard and compact.

a. Red.



- a. Red.  
1. Fine-grained.  
2. Coarse-grained.
- b. Grey, with many and various colours. The granites are seldom flaty or laminated, when their texture is close, and the harder particles, as the felt-spat or rhombic quartz, the quartz, and the shirl, predominate in it. They admit of a good polish; for which reason the Egyptians in former times, and the Italians now, work them into large pieces of ornamental architecture; for which purpose they are extremely fit, as they do not decay in the air.

## 292 II. Conglutinated saxa.

A. Of larger or broken pieces of stones of the same kinds conglutinated together. *Breccia*.  
1. Of limestone cemented by lime.

a. The calcareous breccia; *Breccia calcarea*: the *marmi brecciati* of the Italians.

When these kinds have fine colours, they are polished and employed for ornaments in architecture, and other œconomical uses: they come from Italy.

b. The *lunabella* of the Italians, or shell-marbles. These are a compound of shells and corals, which are petrified or changed into lime, and conglutinated with a calcareous substance. When they have many colours, they are called *marbles*, and employed for the same purposes as the preceding.

293 2. Of kernels of jasper cemented by a jasperly substance. *Breccia jaspidea*. *Diaspro brecciato* of the Italians. Of this kind specimens from Italy are seen in collections. A coarse jasper breccia is said to be found not far from Frejus in Provence in France.

294 3. Of siliceous pebbles, cemented by a jasperly substance, or something like it. The plum-pudding stone of the English. *Breccia siliacea*. Its basis, which at the same time is the cement, is yellow, wherein are contained single flinty or agaty pebbles, of a grey colour or variegated. This is of a very elegant appearance when cut and polished; it is found in England.

295 4. Of quartzose kernels combined with an unknown cement. *Breccia quartzosa*.

296 5. Of kernels of several different kinds of stones. *Breccia saxosa*.

a. Of kernels of porphyry, cemented by a porphyry or coarse jasperly substance; *Breccia porphyrea*.

b. Of kernels of several saxa; *Breccia indeterminata*. Is found in loose stones in Dalarne, and are originally broken from the Fiell tracts in Serna, which consist of nothing else but conglutinated stones.

c. Of conglutinated kernels of sandstone; *Breccia arenacea*. This kind consists of sandstone kernels, which have been combined a second time together.

The above-mentioned breccie of them-

selves must demand the distinctions here made between, but which perhaps may seem to be carried too far, since their particles are so big and plain as to be easily known from one another. These stones are a proof both of the subversions which the mountains in many centuries have undergone, and of some of hidden means which nature makes use of in thus cementing different kinds of stones together. Any certain bigness for the kernels or lumps in such compounds, before they deserve the name of *breccia*, cannot be determined, because that depends on a comparison which every one is at liberty to imagine. At one place in the mountain called *Hykierget*, the kernels of porphyry have a diameter of six feet, while in other places they are no bigger than walnuts. At Massewala, the kernels have a progressive size down to that of a fine sandstone. Most of this kind of stone is fit for ornaments, though the workmanship is very difficult and costly.

B. Conglutinated stones of granules or sands of different kinds. Sandstone; *Lapis arenaceus*.

In this division are reckoned those which consist of such minute particles, that all of them cannot easily be discovered by the naked eye. The greatest part, however, consist of quartz and mica; which substances are the most fit to be granulated, without being brought to a powder.

1. Cemented by clay.

a. With an apyrous or refractory clay; is of a loose texture, but hardens, and is very refractory in the fire.

b. With common clay; from Burfwick in the island of Gotland.

2. With lime; resembles mortar made with coarse sand.

a. Consisting of transparent and greenish grains of quartz and white limestone.

b. Of no visible particles. This is of a loose texture, and hardens in the air.

3. With an unknown cement.

a. Loose.

b. Harder.

c. Compact.

d. Very hard.

4. Cemented by the rust or ochre of iron. Is found in form of loose stones at several places, and ought perhaps to be reckoned among the *minera arenaceæ* or sand-ores; at least when the martial ochre makes any considerable portion of the whole.

C. Stones and ores cemented together; *Minera arenaceæ*. 298

1. Of larger fragments.

a. Mountain green, or *viride montanum cupni*, and pebbles cemented together, from Siberia.

b. Potters lead-ore, with limestone.

c. Yellow or marcasitical copper ore, with small pebbles.

2. Of smaller pieces.

28 X 2

a. Pot-

299

- a. Potters lead-ore with a quartzose fand.  
 b. Mountain green with fand from Siberia.  
 c. Cobalt ore with fand.  
 d. Martial ochre with fand.

trated by mineral salts, *Corpora peregrina infalita*. Metallic changes, &c.  
*Larvæ infalite*.  
 A. With the vitriol of iron.

1. Animals.  
 a. Human bodies have been twice found in the mine at Falun in Dalame; the last was kept a good many years in a glass-case, but began at last to moulder and fall to pieces.

2. Vegetables.  
 a. Turf, and  
 b. Roots of trees.

These are found in water strongly impregnated with vitriol. They do not burn with a flame, but only like a coal in a strong fire; neither do they decay in the air.

III. Extraneous bodies penetrated by mineral inflammable substances, or mineral phlogiston. 305

A. Penetrated by the substance of pit-coals.

1. Vegetables, which commonly have been woods, or appertaining to them.

a. Fully saturated. *Gagas*. Jet.

The jet is of a solid shining texture.

b. Not perfectly saturated; *Mumia vegetabilis*. Is loose; resembles umbre, and may be used as such.

B. Penetrated by rock-oil or asphaltum. 306

1. Vegetables.

a. Turf.

The Egyptian mummies cannot have any place here, since art alone is the occasion that those human bodies have in length of time been penetrated by the asphaltum, in the same manner as has happened naturally to the wood in pit-coal strata.

C. Penetrated by sulphur which has dissolved iron, or by marcasite and pyrites; *Pyrite impregnata*. *Petrifacilia pyritacea*. 307

1. Human.

- a. Bivalves,  
 b. Univalves,  
 c. Insects.

IV. Metals in form of extraneous bodies; *Larvæ metalliferæ*. 308

A. Silver; *Larvæ argentiferæ*.

(1.) Native.

a. On the surfaces of shells.

(2.) Mineralised with copper and sulphur.

a. Fahlerz, or grey silver ore in form of ears of corn, &c. and supposed to be vegetables, are found in argillaceous slate at Frankenberg and Tahlitteren in Hesse.

B. Copper; *Larvæ cupriferæ*.

(1.) Copper in form of calx.

a. In form of animals, or of parts belonging to them. 309

1. Ivory, and other bones of the elephant. The Turcois or Turkey stone. It is of a bluish green colour, and much valued in the east.

At Simore in Languedoc bones of animals are dug, which during the calcination assume a blue colour; but it is not

## SECOND ORDER.

### MINERAL CHANGES, OR THE PETRIFICATIONS.

*Mineralia Larvata*, vulgò *Petrifacilia*,

ARE mineral bodies in the form of animals or vegetables, and for this reason no others belong to this order than such as have been really changed from the subjects of the other two kingdoms of nature. There is more difficulty to determine the first point, viz. from when these bodies are to be styled petrifications, than from when they cease to be such.

I. Earthy changes; *Terræ larvate*. *Terrificata*. 301

A. Extraneous bodies changed into a lime substance, or calcareous changes; *Larvæ calcareæ*.

(1.) Loose or friable. Chalky changes; *Cræta larvata*.

a. In form of vegetables.

b. In form of animals.

1. Calcined or mouldered shells; *Humus conchaceus*.

(2.) Indurated; *Petrifacilia calcareæ*.

a. Changed and filled with solid lime-stone.

1. In form of animals.

2. In form of vegetables.

b. Changed into a calcareous spar; *Petrifacilia calcareæ spatiosa*.

1. In form of animals.

2. In form of vegetables.

B Extraneous bodies changed into a stony substance. Siliceous changes; *Larvæ siliceæ*. These are, like the flint,

(1.) Indurated.

a. Changed into flints.

1. Carnelians in form of shells, from the river Tomm in Siberia.

2. Agat in form of wood. Such a piece is said to be in the collection of Count Tessin.

3. Coralloids of white flint, (*Millepora*).

4. Wood of yellow flint.

C Extraneous bodies changed into clay. Argillaceous changes; *Larvæ argillacæ*. 303

A. Loose and friable.

1. Of porcelain clay.

a. In form of vegetables.

A piece of white porcelain clay from Japan, with all the marks of the root of a tree, has been observed in a certain collection.

2. Indurated.

1. In an unknown clay.

a. In form of vegetables. *Osteocolla*. It is said to be changed roots of the poplar tree, and not to consist of any calcareous substance.

A sort of fossil ivory is said to be found, which has the properties of a clay; but it is doubtful if it is rightly examined.

II. Saline extraneous bodies, or such as are pen- 304

- Changes from decomposition.
- not probable that the blue colour is owing to copper.
- (2.) Mineralised copper, which impregnates extraneous bodies; *Caprum mineralisatum corpora peregrina ingressum*.
- 310 A. With sulphur and iron. The yellow or marcasitic copper-ore that impregnates,
1. Animals.
    - a. Shells.
    - b. In form of fish.
  - B. With sulphur and silver. Grey silver-ore or fahlerts, like ears of corn, from the slate-quarries in Hesse.
- 311 C. Changes into iron; *Larvæ ferriferæ*.
- (1.) Iron in form of calx, which has assumed the place or the shape of extraneous bodies; *Ferrum calciforme corpora peregrina ingressum*.
    - a. Loose; *Larvæ obracææ*.
      1. Of vegetables.
 

Roots of trees, from the lake Langelma in Finland. See the acts of the Swedish Academy of Sciences for the year 1742.
      - b. Indurated; *Larvæ hematitææ*.
        1. Of vegetables.
    - (2.) Iron mineralised, assuming the shape of extraneous bodies.
      - a. Mineralised with sulphur. Marcasite. *Larvæ pyritacææ*.
- 312 V. Extraneous bodies decomposing, or in a way of destruction; *Corpora peregrina in gradibus destructionis considerata*. Mould; *Humus*. Turf; *Turba*.
- 313 A. From animals. Animal-mould; *Humus animalis*.
1. Shells. *Humus conchacææ*.
  2. Mould of other animals; *Humus diversorum animalium*.
- B. Vegetable mould; *Humus vegetabilis*.
1. Turf; *Turba*.
    - a. Solid, and hardening in the air; *Turba solida aëre indurescens*.—Is the best of this kind to be used for fuel, and comes nearest to the pit-coals. It often contains a little of the vitriolic acid.
    - b. Lamellated turba; *Turba foliata*. This is in the first degree of destruction.
  2. Mould of lakes; *Humus lacustris*. This is a black mould which is edulcorated by water.
  3. Black mould; *Humus ater*.
 

This is universally known, and covers the surface of that loose earth in which vegetables thrive best.

in the world, not only where volcanoes yet exist, but likewise where no subterraneous fire is now known: Yet, in Mr Cronstedt's opinion, they cannot be produced but by means of fire. These are not properly to be called *natural*, since they have marks of violence, and of the last change that mineral bodies can suffer without the destruction of the world; nor are they *artificial*, according to the universally-received meaning of this word. When we, perhaps, in future times, by new-discovered means, may be able to find out of what sort of earth stones are compounded, we shall still be forced to stop at the surface of them, and be contented with knowing that they contain a little iron.

- A. Iceland agate; *Achates islandicus niger*. 315  
 It is black, solid, and of a glassy texture; but in thin pieces it is greenish and semi-transparent like glass-bottles, which contain much iron. The most remarkable is, that such large solid masses are found of it, that there is no possibility of producing the like in any glass-house.  
 It is found in Iceland, and in the island of Ascension: The jewellers employ it as an agate, though it is too soft to resist wear.
- B. Rhinish millstone; *Lapis molaris Rhenanus*. 316  
 Is blackish-grey, porous, and perfectly resembles a sort of slag produced by mount Vesuvius.
- C. Pumice-stone; *Pumex*. 317  
 Is very porous and blistered, in consequence of which it is specifically very light. It resembles that frothy slag which is produced in our iron furnaces.
1. White.
  2. Black.
- The colour of the first is perhaps faded or bleached, because the second kind comes in that state from the laboratory itself, viz. the volcanoes.
- D. Pearl slag; *Scoria constantes globulis vitreis conglomeratis*. 318  
 Is compounded of white and greenish glass particles, which seem to have been conglutinated while yet soft, or in fusion. Found on the isle of Ascension.
- E. Slag-sand or ashes; *Scoria pulverulenta cineres vulcanorum*. 319  
 This is thrown out from volcanoes in form of larger or smaller grains. It may perhaps be the principle of the Terra Puzzolana, because such an earth is said at this time to cover the ruins of Herculaneum near Naples, which history informs was destroyed by a volcano during an earthquake.

THIRD ORDER. NATURAL SLAGS.

*Scoria Vulcanorum.*

SLAGS are found in great abundance in many places

M I N

MINERVA, or PALLAS, in Pagan worship, the goddess of sciences and of wisdom, sprung completely armed from Jupiter's brain; and on the day of her nativity it rained gold at Rhodes. She disputed with Neptune the honour of giving a name to the city of Athens; when they agreed that whatsoever of them

M I N

should produce what was most useful to mankind, should have that advantage. Neptune, with a stroke of his trident, formed a horse; and Minerva caused an olive to spring from the ground, which was judged to be most useful, from its being the symbol of peace. Minerva changed Arachne into a spider, for pretending

Minerva  
Mingrelia.

to excel her in making tapestry. She fought the giants; favoured Cadmus, Ulysses, and other heroes; and refused to marry Vulcan, choosing rather to live in a state of celibacy. She also deprived Tiresias of sight, turned Medusa's locks into snakes, and performed several other exploits.

Minerva is usually represented by the poets, painters, and sculptors, completely armed, with a composed but agreeable countenance, bearing a golden breast-plate, a spear in her right-hand, and her ægis or shield in the left, on which is represented Medusa's head encircled with snakes, and her helmet was usually entwined with olives.

Minerva had several temples both in Greece and Italy. The usual victim offered her was a white heifer, never yoked. The animals sacred to her were the cock, the owl, and the basilisk.

MINERVÆ *Castrum*, *Arx Minervæ*, *Minervium*, or *Templum Minervæ*, (anc. geogr.), a citadel, temple, and town on the Ionian sea, beyond Hydrus; seen a great way out at sea. Now *Castro*, a town of Otranto in Naples. E. Long. 19. 25. N. Lat. 46. 8.

MINERVÆ *Promontorium* (anc. geogr.), the seat of the Sirens, a promontory in the Sinus Pæstianus, the fourth boundary of Campania on the Tuscan coast; so called from a temple of Minerva on it: situate to the south of Surrentum, and therefore called *Surrentinum*. Now *Capo della Minerva*, on the west coast of Naples, over-against the island Capri.

MINERVALIA, in Roman antiquity, festivals celebrated in honour of Minerva, in the month of March; at which time the scholars had a vacation, and usually made a present to their masters, called from this festival *minerval*.

MINGRELIA, anciently COLCHIS, a part of Western Georgia, in Asia; bounded on the east by Iberia, or Georgia properly so called; on the west, by the Euxine Sea; on the south, by Armenia, and part of Pontus; and on the north, by Mount Caucasus.

Colchis, or Mingrelia, is watered by a great many rivers; as the Corax, the Hippus, the Cyaneus, the Charidus, the Phasis, where the Argonauts landed, the Abisus, the Cissa, and the Ophis, all emptying themselves into the Euxine Sea. The Phasis does not spring from the mountains in Armenia, near the sources of the Euphrates, the Araxes, and the Tigris, as Strabo, Pliny, Ptolemy, Dionysius, and after them Arrian, Reland, Calmet, and Sanfon, have falsely asserted; but rises on Mount Caucasus; and flows not from south to north, but from north to south, as appears from the map of Colchis or Mingrelia in Thevenot's collection, and the account which Sir John Chardin gives of that country. This river forms in its course a small island, called also *Phasis*; whence the pheasants, if Isidorus is to be credited, were first brought to Europe, and there called by the Greeks *Phasiani*. The other rivers of Colchis are not considerable.

The whole kingdom of Colchis was in ancient times very pleasant and fruitful, as it is still where duly cultivated; abounded in all the necessaries of life; and was enriched with many mines of gold, which gave occasion to the fable of the Golden Fleece and the Argonautic expedition so much celebrated by the ancients.

The latest account we have of this country is from Sir John Chardin, who tells us, that its length is above 100 miles, and its breadth 60; being not near so extensive as the ancient Colchis, which reached from the frontiers of Iberia or Georgia Proper, westward to the Palus Mæotis: that it is beautifully diversified with hills, mountains, valleys, woods, and plains, but badly cultivated: that there are all the kinds of fruits which are found in England, growing wild, but tasteless and insipid for want of culture: that, if the natives understood the art of making wines, those of this country would be the finest in the world: that there are many rivers which have their source in Mount Caucasus, particularly the *Phasis*, now called the *Rione*: that the country abounds in beeves, hogs, wild boars, stags, and other venison; and in partridges, pheasants, and quails: that falcons, eagles, pelicans, lions, leopards, tigers, wolves, and jackals, breed on Mount Caucasus, and sometimes greatly annoy the country: that the people are generally handsome, the men frong and well made, and the women very beautiful; but both sexes very vicious and debauched: that they marry their nieces, aunts, or other relations, indifferently; and take two or three wives if they please, and as many concubines as they will: that they not only make a common practice of selling their children, but even murder them, or bury them alive, when they find it difficult to bring them up: that the common people use a sort of paste, made of a plant called *gorn*, instead of bread; but that that of the better sort consists of wheat, barley, or rice: that the gentry have an absolute power over their vassals, which extends to life, liberty, and estate: that their arms are the bow and arrow, the lance, the sabre or broad-sword, and the buckler: that they are very hairy, and eat sitting cross-legged upon a carpet, like the Persians; but the poorer sort upon a mat or bench, in the same posture: that the country is very thin of inhabitants, no less than 12,000 being supposed to be sold yearly to the Turks and Persians: that the principal commodities exported from it are, honey, wax, hides, castor, martin-skins, flax-seed, thread, silk, and linen-cloth; but that there are no gold or silver mines now, and very little money: that the revenue of the prince or viceroy, amounts to about 20,000 crowns *per annum*: that the inhabitants call themselves *Christians*; but that both they and their priests are altogether illiterate, and ignorant of the doctrines and precepts of Christianity: that there bishops are rich, have a great number of vassals, and are clothed in scarlet and velvet: and that their service is according to the rites of the Greek church, with a mixture of Judaism and Paganism.

The cities of most note in this country in ancient times were Pityus; Diofcurias, or Diofcorias, which was so called from Castor and Pollux, two of the Argonauts, by whom it is supposed to have been founded, and who in Greek are styled *Diofcurioi*, at present known by the name of *Savatapoli*; Aca on the Phasis, supposed to be the same as Hupolis; *Phasis*, so called from the river on which it stood; Cyta, at the mouth of the river Cyaneus, the birth-place of the famous Medea, called from thence, by the poets, *Cytis*; Sarraceæ, Zadris, Surium, Madia, and Zoliffa. As for modern cities, it does not appear that there are any here

Minho. here considerable enough to merit a description; or, if there are, they seem to be little, if at all, known to Europeans.

MINHO, a great river in Spain, which taking its

rise in Galicia, divides that province from Portugal, and falls into the Atlantic at Caminha.

MINIATURE, in a general sense, signifies representation in a small compass, or less than the reality.

## MINIATURE-PAINTING;

**A** DELICATE kind of painting, distinguished from every other species of that art by the following particulars. 1. It is more delicate. 2. It requires a nearer view. 3. It is not easily done but in little. 4. It is wrought only upon vellum, paper, or ivory; and the colours are diluted only with gum-water.

### SECT. I. *Of Drawing and Designing.*

To succeed in this art, a man should be perfectly skilled in the art of designing or drawing: but as most people who affect the one, know little or nothing of the other, and would have the pleasure of painting, without giving themselves the trouble of learning to design, (which is indeed an art that is not acquired without a great deal of time, and continual application), inventions have been found out to supply the place of it; by means of which a man designs or draws, without knowing how to design.

The first is chalking: that is, if you have a mind to do a print or design in miniature, the back-side of it, or another paper, must be blackened with small-coal, and then rubbed very hard with the finger wrapped in a linen cloth: afterwards the cloth must be lightly drawn over the side so blackened that no black grains may remain upon it to soil the vellum you would paint upon; and the print or draught must be fastened upon the vellum with four pins, to keep it from shifting. And if it be another paper that is blackened, it must be put between the vellum and the print, or draught, with the blackened side upon the vellum. Then, with a blunted pin or needle, you must pass over the principal lines or strokes of the print, or draught, the contours, the plaits of the drapery, and over every thing else that must be distinguished; pressing so hard, that the strokes may be fairly marked upon the vellum underneath.

Copying by squares is another convenient method for such as are but little skilled in the art of designing, and would copy pictures, or other things, that cannot be chalked. The method is this: The piece must be divided into many equal parts by little squares, marked out with charcoal, if the piece be clear and whitish, and the black can be fairly seen upon it; or with white chalk, if it be too brown and dusky. After which, as many squares of equal dimensions must be made on white paper, upon which the piece must be designed; because, if this be done immediately upon vellum, (as one is apt to miscarry in the first attempt), the vellum may be soiled with false touches. But when it is neatly done upon paper, it must be chalked upon the vellum in the manner before described. When the original and the paper are thus ordered, observe what is in each square of the piece to be designed; as a head, an arm, a hand, and so forth; and place it in the corresponding part of the paper. And thus finding where to place all the parts of the piece, you have nothing to

do but to form them well, and to join them together. By this method you may reduce or enlarge a piece to what compass you please, making the squares of your paper greater or lesser than those of the original; but they must always be of an equal number.

To copy a picture, or other thing, in the same size and proportion, another method is, to make use of varnished paper, or of the skin of a hog's bladder, very transparent, such as is to be had at the gold-beaters. Talc or isinglass will likewise do as well. Lay any one of those things upon your piece; through it you will see all the strokes and touches; which are to be drawn upon it with a crayon or pencil. Then take it off; and fastening it under paper or vellum, set up both against the light in the manner of a window; and with a crayon, or a silver needle, mark out upon the paper or vellum you have put uppermost, all the lines and touches you shall see drawn upon the varnished paper, bladder, talc, or isinglass, you have made use of, and which will plainly appear through this window.

After this manner, making use of the window, or of glass exposed to the light, you may copy all sorts of prints, designs, and other pieces, on paper or vellum; laying and fastening them under the paper or vellum upon which you would draw them. And it is a very good and a very easy contrivance for doing pieces of the same size and proportion.

If you have a mind to make pieces look another way, there is nothing to be done but to turn them; laying the printed or drawn side upon the glass, and fastening the paper or vellum upon the back of it; remembering to let your lights fall on the left side.

A good method likewise to take a true copy of a picture in oil, is to give a touch of the pencil upon all the principal strokes, with lake tempered with oil; and to clap upon the whole a paper of the same size: then passing the hand over it, the touches of the lake will stick and leave the design of your piece expressed upon the paper, which may be chalked like other things. But you must remember to take off with the crumb of bread what remains of the lake upon the picture before it be dry.

You must likewise make use of pounce, made of powdered charcoal put in a linen-rag; with which the piece you would copy must be rubbed, after you have pricked all the principal strokes or touches, and fastened white paper or vellum underneath.

But a surer and easier help than all these for one who knows nothing of designing, is a mathematical compass; it is generally made of ten pieces of wood, in form of rulers, half a quarter of an inch thick, half an inch broad, and a foot long, or more, according as you have a mind to draw pieces of a greater or lesser size. To facilitate the construction of this instrument, a figure is given, with an explanation of the manner in which it is to be used.

The little board A is to be of fir, and covered with

See  
Plate  
CLXXXIX.  
fig. 4.

linen,

linen, or any other cloth; because the piece you copy, and the vellum or paper you copy upon, must be fixed upon it. Upon this board mult the compass also be fixed with a pin, by the end of the first foot B, deep enough to keep it close, but not so deep as to hinder it from turning easily. When you have a mind to reduce things, place your original on the side of the foot C, and the vellum or paper you would draw upon on the side of the foot B; removing the vellum or drawing it nearer, according as you intend to reduce or enlarge.

In order to enlarge a piece, you have nothing to do but to change the places of your original and your copy; placing the last towards C, and the other on the side of B.

And in both one and the other method, a crayon or leaden needle must be put in the foot under which the vellum lies; and a pin, a little blunted, in that over the original, with which all the traces are to be followed; conducting the pin with one hand, and with the other pressing gently upon the crayon or needle that marks the vellum. When the crayon or needle bears sufficiently upon the vellum, you have no occasion to touch it.

By this instrument you may also drawn in equal dimensions: but in order to this, the compass must be fixed in another manner upon the board; for if it is to be fastened upon it by the middle at D, and your original and your copy must be fixed on each side of this middle foot, at the equal distances, or from corner to corner; that is, from C to E, when the pieces are large. One may likewise draw several copies at once of equal and different dimensions.

When your piece is marked out upon the vellum, you must pass with a pencil of very clear carmine over all the traces, to the end they may not be effaced as you work: then clean your vellum with the crumb of bread, that no black may remain upon it.

Your vellum must be pasted upon a little plate of brass or wood, of the size you would make your piece, to keep it firm and tight: but this pasting must be on the edges of your vellum only, and behind the plate; for which purpose your vellum must exceed your plate above an inch on every side: for the part you paint upon must never be pasted; because it would not only give it an ill look, but you could not take it off if you would. Cut off the little shags and locks of the vellum; and wetting the fair side with a linen-cloth, dipped in water, clap the other upon the plate with a clean paper between them: so much as hangs over must be pasted upon the back of the plate, drawing it equally on all sides, and hard enough to stretch it well.

### SECT. II. Of Materials.

THE chief colours made use of for painting in miniature, are

Carmine.  
Venice and Florence lake.  
Rose pink.  
Vermilion.  
Red-lead.  
Brown red.  
Red opiment.  
Ultramarine.  
Verditer.

Indigo.  
Gall-stone.  
Yellow-ochre.  
Dutch pink.  
Gamboge.  
Naples yellow.  
Pale masticot.  
Deep yellow masticot.  
Ivory-black.  
Lamp-black.  
True Indian ink.  
Bistre, or wood-foot.  
Raw umber.  
Burnt umber.  
Sap-green.  
Verdigrife.  
Flake-white.  
Crayons of all colours.  
Gold and silver shells.  
Leaf-gold and leaf-silver.

The seven transparent colours, which are used where writing is seen through the colour.

Liquid	}	Lake.
		Blue.
		Yellow.
		Grass-green.
		Dark-green.
		Purple-colour.
		Brown.

Most of these colours necessary for miniature-painting may easily be prepared by attending to the directions given under the article COLOUR-Making.

As colours taken from earth and other heavy matter are always too coarse, be they never so well ground, especially for delicate work, because of a certain sand remaining in them; the finest parts may be drawn out by diluting them with the finger in a cup of water. When they are well steeped, let them settle a while; then pour out the clearest, which will be at top, into another vessel. This will be the finest, and must be let dry; and when it is used, must be diluted with gum-water.

If you mix a little of the gall of an ox, a carp, or an eel, particularly of the last, in green, black, grey, yellow, and brown, colours, it will not only take away their greasy nature, but also give them a lustre and brightness they have not of themselves. The gall of eels must be taken out when they are skinned, and hung upon a nail to dry; and when you would use it, it must be diluted with brandy; add a little of it mixed with the colour you have diluted already. This likewise makes the colour stick better to the vellum, which it hardly does when it is greasy: moreover, this gall hinders it from sealing.

Some colours are made clearer by fire, as yellow ochre, brown red, ultramarine, and umber: all others are darkened by it. But if you heat the said colours with a sharp fire, they change; for the brown red becomes yellow; yellow ochre becomes red; umber reddens also. Cerus by fire takes the colour of citron, and is often called *masticot*. Observe, that yellow ochre heated, becomes more tender than it was, and softer than brown red. Likewise brown red heated becomes softer than fine yellow ochre. Both are very proper. The finest and truest ultramarine, heated upon a red-hot

hot iron, becomes more glittering; but it wastes, and is coarser and harder to work with in miniature.

All these colours are diluted in little cups of ivory, made on purpose, or in sea shells, with water in which gum-arabic and sugar-candy are put. For instance, in a glass of water put a piece of gum as big as a walnut, and half that quantity of sugar-candy. This last hinders the colours from scaling when they are laid on, which they generally do when they want it, or the vellum is greasy.

This gum-water must be kept in a neat bottle corked; and you never must take any out of it with a pencil that has colour upon it, but with a quill or some such thing.

Some of this water is put in the shell with the colour you would temper, and diluted with the finger till it be very fine. If it be too hard, you must let it soften in the shell with the said water before you dilute it. Afterwards let it dry: and do thus with every colour, except lily-green, sap-green, and gamboge, which must be tempered with fair water only. But ultramarine, lake, and bistre, are to be more gummed than other colours.

If you make use of sea-shells, you must let them steep two or three days beforehand in water: then cleanse them in boiling-hot water, mixed with vinegar, in order to carry off a certain salt, which otherwise sticks to them, and spoils the colours that are put to them.

To know whether colours are sufficiently gummed, you have nothing to do but to give a stroke of the pencil upon your hand when they are diluted, which dries immediately: if they chap and scale, there is too much gum; if they rub out by passing the finger over them, there is too little. It may be seen likewise when the colours are laid on the vellum, by passing the finger over them. If they stick to it like a powder, it is a sign there is not gum enough, and more must be put to the water with which you temper them: but take care you do not put too much; for that makes the colour extremely hard and dry. It may be known likewise by their glueiness and brightness: so the more they are gummed, the darker they paint; and when you have a mind to give a greater strength to a colour than it has of itself, you have nothing to do but to give it a great deal of gum.

Provide yourself with an ivory pallet, very smooth, as big as your hand; on one side of which the colours for the carnation, or naked parts of a picture, are to be ranged in the following manner. In the middle put a great deal of white, pretty largely spread; because it is the colour most made use of: and upon the edge, from the left to the right, place the following colours at a little distance from the white.

Masticot.

Dutch pink.

Orpiment.

Yellow-ochre.

Green; composed of verditer, Dutch pink, and white, in equal quantities.

Blue; made of ultramarine, Indigo, and white, to a great degree of paleness.

Vermilion.

Carmine.

Bistre, and  
Black.

On the other side of the pallet, spread some white in the same manner as for the carnation. And when you have a mind to paint draperies, or other things, place near the white the colour you would make them of, in order to work as shall be shew'd hereafter.

The use of good pencils is a great matter. In order to make a good choice, wet them a little; and if the hairs keep close together as you turn them upon the finger, and make but one point, they are good: but if they close not together, but make several points, and some are longer than others, they are good for nothing. When they are too sharp-pointed, with only four or five hairs longer than the rest, yet closing all together, they are, notwithstanding, good; but they must be blunted with a pair of scissars, taking care at the same time you do not clip away too much. It is proper to have two or three sorts of them; the largest for laying the grounds and dead-colouring, and the smallest for finishing.

To bring the hairs of your pencil to join close together and make a good point, you must often put the pencil just between your lips when you are at work; moistening and pressing it close with the tongue, even when there is colour upon it; for if there be too much, some of it is taken off by this means, and enough left for giving fine and equal touches. You need not apprehend this will do you any harm. None of the colours for miniature, except orpiment, when they are prepared, have either ill taste or ill quality. This expedient must especially be used for dotting, and for finishing, particularly the naked parts of a picture, that the touches may be neat and fair, and not too much charged with colour. As for draperies and other things, as well in dead-colouring as in finishing, it is sufficient, in order to make the hairs of your pencil join well, and to unload it when it has too much colour, to draw it upon the edge of the shell, or upon the paper you must put upon your work to rest your hand on, giving some strokes upon it before you work upon your piece.

To work well in miniature, you must do it in a room that has but one window, and fix yourself very near it, with a table and desk almost as high as the window; placing yourself in such a manner, that the light may always come in on the left side, and never forward or on the right.

When you would lay a colour on all parts equally strong, as for a ground, you must make your mixtures in shells, and put in enough for the thing you design to paint; for if there be not enough, it is a great chance but the colour you mix afterwards is too dark or too light.

### SECT. III. Of Working.

AFTER having spoke of vellum, pencils, and colours, let us now shew how they are to be employed. In the first place, then, when you would paint a piece, be it carnation, drapery, or any thing else, you must begin by dead-colouring; that is to say, by laying your colours on with liberal strokes of the pencil, in the smoothest manner you can, as the painters do in oil; not giving it all the force it is to have for a finishing: that

that is, make the lights a little brighter, and the shades less dark, than they ought to be; because in dotting upon them, as you must do after dead-colouring, the colour is always fortified, and would at last be too dark.

There are several ways of dotting; and every painter has his own. Some make their dots perfectly round. Others make them a little longish. Others hatch by little strokes that cross each other every way, till the work appears as if it had been wrought with dots. This last method is the best, the boldest, and the soonest done. Wherefore such as would paint in miniature ought to use it, and to inure themselves from the first to dot in the plump and the soft way; that is to say, where the dots are lost, in a manner, in the ground upon which you work, and only so much appears as is sufficient to make the work seem dotted. The hard and the dry way is quite the reverse, and always to be avoided. This is done by dotting with a colour, much darker than your ground, and when the pencil is not moistened enough with the colour, which makes the work seem rough and uneven.

Study likewise carefully to lose and drown your colours one in another, so that it may not appear where they disjoin; and to this end, soften or slay your touches with colours that partake of both, in such sort that it may not appear to be your touches which cut and disjoin them. By the word *cut*, we are to understand what manifestly separates and divides, and does not run in and blend itself with the neighbouring colours; which is rarely practised but upon the borders of drapery.

When your pieces are finished, to heighten them a little, gives them a fine air; that is to say, give, upon the extremity of the lights, small touches with a colour yet lighter, which must be lost and drowned with the rest.

When the colours are dry upon your pallet or in your shells, in order to use them, they must be diluted with water. And when you perceive they want gum, which is seen when they easily rub off the hand or the vellum if you give a touch with them upon either, they must be tempered with gum-water instead of pure water, till they are in condition.

There are several sorts of grounds for pictures and portraits. Some are wholly dark, composed of bistre, umber, and Cologne earth, with a little black and white; others more yellow, in which is mixed a great deal of ochre; others greyer, which partake of indigo. In order to paint a ground, make a wash of the colour or mixture you would have it, or according to that of the picture or portrait you would copy; that is to say, a very light lay, in which there is hardly any thing but water, in order to soak the vellum. Then pass another lay over that, somewhat thicker, and strike it on very smoothly with large strokes as quick as you can, not touching twice in the same place before it be dry; because the second stroke carries off what has been laid on at the first, especially when you lean a little too hard upon the pencil.

Other dark grounds are likewise made of a colour a little greenish: and those are most in use, and the properest to lay under all sorts of figures and portraits; because they make the carnation, or naked parts of a picture, appear very fine; are laid on very easily, and

there is no occasion to dot them, as one is often obliged to do the others, which are rarely made smooth, and even at the first; whereas in these one seldom fails of success at the first bout. To make them, you must mix black, Dutch pink, and white, all together; more or less of each colour, according as you would have them darker or lighter. You are to make one lay very light, and then a thicker, as of the first grounds. You may also make them of other colours, if you please; but these are the most common.

When you paint a holy person upon one of these grounds, and would paint a small glory round the head of your figure, you must not lay the colour too thick in that part, or you may even lay none at all, especially where this glory is to be very bright; but lay for the first time with white and a little ochre mixed together, of a sufficient thickness; and in proportion as you go from the place of the head, put a little more ochre; and to make it lose itself, and die away with the colour of the ground, hatch with a free stroke of the pencil, following the round of the glory, sometimes with the colour of which it is made, and sometimes with that of the ground, mixing a little white or ochre with the last when it paints too dark to work with: and do this till one be insensibly lost in another, and nothing can be seen to disjoin them.

To fill an entire ground with a glory, the brightest part is laid on with a little ochre and white, adding more of the first in proportion as you come nearer the edges of the picture: and when the ochre is not strong enough (for you must always paint darker and darker), add gall-stone, afterwards a little carmine, and lastly bistre. This first laying, or dead-colouring, is to be made as soft as possible; that is to say, let these showings lose themselves in one another without gap or intersection. Then the way is to dot upon them with the same colours, in order to drown the whole together; which is pretty tedious, and a little difficult, especially when there are clouds of glory on the ground. Their lights must be fortified in proportion as you remove from the figure, and finished as the rest, by dotting and rounding the clouds; the bright and obscure parts of which must run insensibly into one another.

For a day-sky, take ultramarine and a good deal of white, and mix them together. With this make a lay, as smooth as you can, with a large pencil and liberal strokes, as for grounds; applying it paler and paler as you descend towards the horizon; which must be done with vermilion or red lead, and with white of the same strength with that where the sky ends, or something less; making this blue lose itself in the red, which you bring down to the skirts of the earth, or tops of houses; mixing towards the end gall-stone and a good deal of white, in such a manner that the mixture be still paler than the former, without any visible intersection or parting between all these colours of the sky.

When there are clouds in the sky, you may spare the places where they are to be; that is to say, you need not lay on any blue there, but form them, if they are reddish, with vermilion, gall-stone, and white, with a little Indigo; and if they are more upon the black, put in a good deal of the last; painting the lights of one and the other with mallow, vermilion, and white, more or less of any of these colours, according



Of  
Draperies.

to the strength you would give them, or according to that of the original you copy; rounding the whole as you dot; for it is a difficult matter to lay them very smooth at the first painting: and if the sky is not even enough, you must dot it also.

It is at your pleasure to exempt the places of the clouds, for you may lay them upon the ground of the sky; heightening the bright parts by putting a good deal of white, and fortifying the shadows by using less. This is the shortest way.

A night or stormy sky is done with indigo, black, and white, mixed together; which is laid as for a day-sky. To this mixture must be added ochre, vermilion, or brown-red, for the clouds; the lights of which are to be of masticot, or red-lead, and a little white; now redder, now yellower, at discretion. And when it is a tempestuous sky, and lightning appears in some places, be it blue or red, it is to be done as in a day-sky, drowning and losing the whole together at the first forming or dead-colouring, and at the finishing.

SECT. IV. *Of Draperies.*

To paint a blue drapery, put ultramarine near the white upon your pallet; and mix a part of the one with the other, till it makes a fine pale, and has a body. With this mixture you must form the brightest parts; and then adding more ultramarine, form such as are darker; and go on after this manner till you come to the deepest plaits and the thickest shades, where you must lay pure ultramarine: and all this must be done as for a first-forming or dead-colouring; that is to say, laying the colour on with free strokes of the pencil, yet as smooth as you can; losing the lights of the shadows with a colour neither so pale as the lights, nor so dark as the shades. Then dot with the same colour as in the first-forming, but a small matter deeper; that the dots may be fairly seen. All the parts must be drowned one in another, and the plaits appear without interfection. When the ultramarine is not dark enough to make the deeper shadows, how well soever it be gummed, mix a little Indigo with it to finish them. And when the extremities of the lights are not bright enough, heighten them with white and a very little ultramarine.

A drapery of carmine is done in the same manner as the blue; except that in the darkest places there is to be a lay of pure vermilion, before you dead-colour with carmine, which must be applied at top; and in the strongest shades, it must be gummed very much. To deepen it the more, mix a little bistre with it.

There is likewise made another red drapery, which is first drawn with vermilion, mixing white with it to dead-colour the bright places; laying it pure and unmixed for those that are darker, and adding carmine for the grand shades. It is finished afterwards, like other draperies, with the same colours. And when the carmine with the vermilion do not darken enough, work with the first alone, but only in the deepest of the shades.

A drapery of lake is made in the same manner with that of carmine; mixing a good deal of white with it for the bright places, and very little for those that are dark. It is finished likewise with dotting; but you have nothing to do with vermilion in it.

Violet-draperies are likewise done after this manner; after making a mixture of carmine and ultramarine, putting always white for the bright parts. If you would have your violet be columbine or dove-colour, there must be more carmine than ultramarine: but if you would have it bluer and deeper, put more ultramarine than carmine.

A drapery is made of a flesh-colour, beginning with a lay made of white, vermilion, and very pale lake; and making the shades with the same colours, using less white in them. This drapery must be very pale and tender, because the stuff of this colour is thin and light; and even the shades of it ought not to be deep.

To make a yellow drapery, put a lay of masticot over all; then one of gamboge upon that, excepting the brightest places, where the masticot must be left entire; the dead-colour with ochre, mixed with a little gamboge and masticot, putting more or less of the last according to the strength of the shades. And when these colours do not darken enough, add gall-stone. And gall-stone pure and unmixed is used for the thickest shades; mixing a little bistre with it, if there be occasion to make them still darker. You finish by dotting with the same colours you dead-coloured with, and losing the lights and the shades in one another.

If you put Naples-yellow, or Dutch-pink, in lieu of masticot and gamboge, you will make another sort of yellow.

The green drapery is made by a general lay of verditer; with which, if you find it too blue, mix masticot for the lights, and gamboge for the shades. Afterwards add to this mixture lily-green or sapphire-green, to shadow with; and as the shades are thicker, put more of these last greens, and even work with them pure and unmixed where they are to be extremely dark. You finish with the same colours, a little darker.

By putting more yellow, or more blue, in these colours, you may make different sorts of greens as you please.

To make a black drapery, you dead-colour with black and white, and finish with the same colour, putting more black, as the shades are thicker; and for the darkest, mix indigo with it, especially when you would have the drapery appear like velvet. You may always give some touches with a brighter colour, to heighten the lights of any drapery whatsoever.

A white woolen drapery is made by a lay of white, in which there must be a very small matter of ochre, orpiment, or gall-stone, that it may look a little yellowish. Then dead-colour, and finish the shades with blue, a little black, white, and bistre; putting a great deal of the last in the darkest.

The light-grey is begun with black and white, and finished with the same colour deeper.

For a brown drapery, make a lay of bistre, white and a little brown-red; and shadow with this mixture, made a little darker.

There are other draperies, called *variable*, because the lights are of a different colour from the shades. These are mostly used for the vestments of angels, for young and gay people, for scarfs and other airy attire, admitting of a great many folds, and flowing at the

pleasure

pleasure of the wind. The most common are the violets: of which they make two sorts; one, where the lights are blue; and the other, where they are yellow.

For the first, put a lay of ultramarine and very pale white upon the lights; and shadow with carmine, ultramarine, and white, as for a drapery wholly violet; so that only the grand lights appear blue. Yet they must be dotted with violet, in which there is a great deal of white, and lost insensibly in the shades.

The other is done by putting upon the lights only, instead of blue, a lay of malicot; working the rest as in the drapery all violet, excepting that it must be dotted, and the light parts blended with the shadow, that is, the yellow with the violet, with a little gamboge.

The carmine-red is done like the last; that is, let the lights be done with malicot, and the shades with carmine; and to lose the one in the other, make use of gamboge.

The lake-red is done like that of carmine.

The green is done as the lake; always mixing verditer with lily or sap-green, to make the shades; which are not very dark.

Several other sorts of draperies may be made at discretion, always taking care to preserve the union of the colours, not only in one sort of cloth or so, but also in a group of several figures; avoiding, as much as the subject will allow, the putting of blue near the colour of fire, of green against black; and so of other colours which cut and disjoin, and whose union is not kind enough.

Several other draperies are made of foul colours, as brown-red, bistre, indigo, &c. and all in the same manner. Likewise of other colours, simple and compound; the agreement between which is always to be minded, that the mixture may produce nothing harsh and disagreeable to the eye. No certain rule can be laid down for this. The force and effect of your colours are only to be known from use and experience, and you must work according to that knowledge.

Linen-cloths are done thus: After drawing the plaits or folds, as is done in a drapery, put a lay of white over all; then dead-colour, and finish the shades with a mixture of ultramarine, black, and white, using more or less of the last, according to their strength or tenderness; and in the greatest deepening put bistre, mixed with a little white; giving only some touches of this mixture, and even of pure bistre, upon the extremities of the greatest shadows, where the folds must be drawn, and lost with the rest.

They may be done in another manner, by making a general lay of this mixture of ultramarine, black and very pale white; and dead-colour (as has been said before) with the same colour, but a little deeper. And when the shades are dotted and finished, heighten the lights with pure white, and lose them with the deepening of the linen. But of whatever sort you make them, when they are finished, you must give a yellowish taint of orpiment and white to certain places; laying it lightly on, and as it were in water; so that what is underneath may, notwithstanding, plainly appear, as well the shadows as the dotting.

Yellow linen-cloth is done by putting a lay of white, mixed with a little ochre. Then form and finish the shades with bistre, mixed with white and ochre; and in the thickest shades use pure bistre: and before you finish, give some teints here and there of ochre and white, and others of white and ultramarine, as well upon the shades as the lights; but let them be very bright; and draw the whole together in dotting, and it will look finely. As you finish, heighten the extremities of the lights with malicot and white. You may add to this sort of linen, as well as to the white, certain bars from space to space, as in Turkey-mantuas; that is, small stripes blue and red with ultramarine and carmine; one of red between two of blue, very bright and clear upon the lights, and deeper upon the shades. Virgins are pretty often dressed with veils of this sort (by Popish painters), and scarfs of this kind are put about necks that are bare; because they become the teint mighty well.

If you would have both these sorts of linen transparent, and the stuff or other thing that is beneath appear through them, make the first lay for them very light and clear, and mix in the colour to shadow with, a little of that which is underneath, especially towards the end of the shades; and only do the extremities of the lights, for the yellow, with malicot and white; and for the white, with pure white.

They may be done in another manner, especially when you would have them altogether as clear as muslin, lawn, or gauze. To this end form and finish what is to be beneath, as if nothing was to be put over it. Then mark out the light and clear folds with white or malicot; and a shadowy with bistre and white, or with black, blue, and white, according to the colour you would make them of; making the rest somewhat fainter: yet this is not necessary but for the parts that are not to be so clear.

Crape is done the same way; excepting that the folds of the shades and the lights, and the borders too, are to be marked out with little filaments of black upon what is underneath; which is likewise to be finished beforehand.

When you would make a stuff like a watered tabby, make the waves upon it with a colour a little lighter, or a little darker, in the lights and the shades.

There is a manner of touching draperies which distinguishes the silken from the woolen. The last are more terrestrial and sensible; the others more light and fading. But it must be observed, that this is an effect which depends partly upon the stuff and partly upon the colour; and for the employing these in a manner suitable to the subjects and the deepening of painting, we shall here touch upon their different qualities.

We have no colour which partakes more of light, nor which comes nearer the air, than white; which shews it to be sickle and feeble. It may, nevertheless, be held and brought to by some neighbouring colour, more heavy and sensible, or by mixing them together.

Blue is a most fleeting colour: and so we see, that the sky and the remotest views of a picture are of this colour; but it will become lighter and sickler, in proportion as it is mixed with white.

Pure black is the heaviest and most terrestrial of all

colours; and the more of it you mix with others, the nearer you bring them to the eye.

Nevertheless, the different dispositions of black and white make also their effects different: for white often makes black disappear, and black brings white more into view; as in the reflection of globes, or other figures to be made round, where there are always parts that fly as it were from the eye, and deceive it by the craft of art: and under the white are here comprehended all the light colours; as under the black, all the heavy colours.

Ultramarine is, then, soft and light.

Ochre is not so much so.

Mallicot is very light; and so is verditer.

Vermilion and carmine come near this quality.

Orpiment and gamboge not so near.

Lake holds a certain mean, rather soft than rough.

Dutch pink is an indifferent colour, easily taking the quality of others. So it is made terrestrial by mixing it with colours that are so; and, on the contrary, the most light and fleeting by joining it with white or blue.

Brown-red, amber, dark greens, and bistre, are the heaviest and most terrestrial, next to black.

Skilful painters, who understand perspective, and the harmony of colours, always observe to place the dark and sensible colours on the fore-parts of their pictures; and the most light and fleeting they use for the distances and remote views. And as for the union of colours, the different mixtures that may be made of them will learn you the friendship or antipathy they have to one another. And upon this you must take your measures for placing them with such agreement as shall please the eye.

For the doing of lace, French-points, or other things of that nature, put over all a lay of blue, black, and white, as for linen: then heighten the flower-work with pure white: afterwards make the shades above with the first colour, and finish them with the same. When they are upon the carnation or naked parts of a picture, or upon any thing else that you would show through another, finish what is beneath, as if nothing was to be put over it: and at top, make the points or lacc with pure white, shadowing and finishing them with the other mixture.

If you would paint a fur, you must begin with a kind of drapery, done, if it be dark, with bistre and white, making the shadowings of the same colour, with less white. If the fur be white, do it with blue, white, and a little bistre. And when this beginning, or first-forming, is done, instead of dotting, draw small strokes, turning, now in one manner, now in another, according to the course and flattening of the hair. Heighten the lights of dark furs with ochre and white, and of the other with white and a little blue.

For doing a building, if it be of stone, take indigo, bistre, and white, with which make the beginning or first form of it; and for shadowing it, put less of this last; and more bistre than indigo, according to the colour of the stone you would paint. To these you may likewise add a little ochre, both for the forming and the finishing. But to make it finer, you must give, here and there, especially for old fabrics, blue and yellow tints, some with ochre, others with ultramarine, mixing always white with them, whether before

the first-forming, provided they appear through the draught, or whether upon it, losing or drowning them with the rest when you finish.

When the building is of wood, as there are many sorts, it is done at discretion; but the most ordinary way is to begin or first-form with ochre, bistre, and white, and finish without white, or with very little; and if the shades are deep, with pure bistre. In the other they add sometimes vermilion, sometimes green or black; in a word, just according to the colour they would give it; and they finish with dotting, as in draperies and every thing else.

#### SECT. V. *Of Carnations, or the naked parts of Painting.*

THERE are in carnation so many different colourings, that it would be a difficult thing to give general rules upon so variable a subject. Nor are they minded, when one has got, by custom and practice, some habit of working easily: and such as are arrived to this degree, employ themselves in copying their originals, or else they work upon their ideas, without knowing how: insomuch, that the most skilful, who do it with less reflection and pains than others, would likewise be more put to it to give an account of their maxims and knowledge in the matter of painting, if they were to be asked what colours they made use of for such and such a colouring, a tint here, and another there.

Nevertheless, as beginners want some instruction at the first, we will show in general, after what manner several carnations are to be done.

In the first place, after having drawn your figure with carmine, and ordered your piece, apply, for women and children, and generally for all tender colourings, a lay of white, mixed with a very little of the blue made for faces, of which we have told the composition; but let it hardly be seen.

And for men, instead of blue, they put in this first lay a little vermilion; and when they are old, a little ochre is mixed with it.

Afterwards follow all the traces with vermilion, carmine, and white; mixed together; and begin all the shades with this mixture, adding white in proportion as they are weaker; and putting but little in the darkest, and none, in a manner, in certain places where strong touches are to be given: for instance, in the corner of the eye; under the nose; at the ears; under the chin; in the separations of the fingers; in all joints; at the corners of the nails; and generally in every part where you would mark out separations in shades that are obscure. Neither need you fear to give to those places all the force and strength they ought to have as soon as you begin or first-form them, because in working at top with green, the red you have put there is always weakened.

After having begun, or first-formed, or dead-coloured, with red, make blue tints with ultramarine and a great deal of white, upon the parts which fly from the eye; that is to say, upon the temples; under and in the corners of the eyes; on both sides the mouth, above and below; a little upon the middle of the forehead; between the nose and the eyes; on the side of the cheeks; on the neck and other places

where.

where the flesh assumes a bluish cast. Yellowish teints are likewise made with ochre or orpiment, and a little vermilion mixed with white, under the eye-brows, on the sides of the nose towards the bottom, a little underneath the cheeks, and upon the other parts which rise and come nearer the eye. It is especially from these teints that the natural complexion is to be observed, in order to catch it; for painting being an imitation of nature, the perfection of the art consists in the justness and simplicity of the representation, especially in face-painting.

When, therefore, you have done your first lay, your dead colouring, and your teints, you must work upon the shades, dotting with green for the carnations or naked parts; mixing, according to the rule we have given for the teints, a little blue for the parts which fly from the eye; and, on the other hand, making it a little yellower for those that are more sensible; that is to say, which rise, and come nearer the eye; and at the end of the shades, on the side of the light, you must blend and lose your colour insensibly in the ground of the carnation with blue, and then with red, according to the places where you paint. If this mixture of green does not work dark enough at first, pass over the shades several times, now with red, and now with green; always dotting: and this do till they are as they should be.

And if you cannot with these colours give the shades all the force they ought to have, finish, in the darkest, with bistre mixed with orpiment, ochre, or vermilion, and sometimes with pure bistre, according to the colouring you would make, but lightly, laying on your colour very clear.

You must dot upon the clear and bright places with a little vermilion or carmine, mixed with much white, and a very small matter of ochre, in order to lose them with the shadowy, and to make the teints die away insensibly into one another; taking care, as you dot, or hatch, to make your strokes follow the turnings and windings of the fleshy parts. For though the rule be to cross always, this dotting or hatching ought to appear a little more here, because it rounds the parts. And as this mixture might make a colouring too red, if it was always to be used, they work likewise in every part, to blend the teints and the shades, with blue and a little green, and much white, so mixed as to be very pale; excepting, nevertheless, that this colour must not be put upon the cheeks, nor upon the extremities of the clear parts, no more than the other mixture upon these last, which must be left with all their light; as certain places of the chin, of the nose, and of the forehead, and upon the cheeks; which, and the cheeks, ought nevertheless to be redder than the rest, as well as the feet, the hollows of the hands, and the fingers of both.

Observe, that these two last mixtures ought to be so pale, that the work shall hardly be visible; for they serve only to soften it; to unite the teints with one another, and the shades with the lights, and to drown the traces. Care must likewise be taken that you work not too much with the red mixture upon the blue teints, nor with the blue upon the others; but change the colour from time to time, when you perceive it works too blue or too red, till the work be finished.

The white of the eyes must be shadowed with this same blue, and a little flesh-colour; and the corners, on the side of the nose, with vermilion and white; giving them a little touch of carmine. The whole is softened with this mixture of vermilion, carmine, white, and a very small matter of ochre.

The apples or balls of the eyes are done with the mixture of ultramarine and white; the last prevailing a little; adding a little bistre, if they are yellowish; or a little black, if they are grey. Make the little black circle in the middle, called the *crystal of the eye*; and shadow the balls with indigo, bistre, or black, according to the colour they are of; giving to each a small touch of pure vermilion round the crystal; which must be lost with the rest at the finishing. This gives vivacity to the eye.

The round or circumference of the eye is done with bistre and carmine; that is to say, the flits or partings, and the eye-lids, when they are large and bold; especially the upper ones; which must afterwards be softened with the red or blue mixtures we have mentioned before, to the end they may be lost in one another, and nothing seem interected. When this is done, give a little touch of pure white upon the crystal, on the side of the lights. This makes the eye shine, and gives life to it.

The mouth is dead-coloured with vermilion, mixed with white; and finished with carmine, which is softened as the rest. And when the carmine does not work dark enough, mix a little bistre with it. This is to be understood of the corners in the separation in the lips; and particularly, of certain mouths half open.

The hands, and all the other parts of carnation, are done in the same manner as the faces; observing, that the ends of the fingers be a little redder than the rest. When your whole work is formed and dotted, mark the separations of all the parts with little touches of carmine and orpiment mixed together, as well in the shadowy as the light places; but a little deeper and stronger in the first; and lose them in the rest of the carnation.

The eye-brows and the beard are dead-coloured, as are the shades of carnations; and finished with bistre, ochre, or black, according to the colour they are of, drawing them by little strokes the way they ought to go; that is to say, give them all the nature of hair. The lights of them must be heightened with ochre and bistre, a little vermilion, and much white.

For the hair of the head, make a lay of bistre, ochre, and white, and a little vermilion. When it is very dark-coloured, use black instead of ochre. Afterwards form the shadowy parts with the same colours, putting less white in them; and finish with pure bistre, or mixed with ochre or black, by small strokes very fine, and close to each other, waving and buckling them according to the curling of the hair. The light parts must also be heightened by little strokes with ochre or orpiment, white, and a little vermilion. After which, lose the lights and the shades in each other, by working sometimes with a dark, and sometimes with a pale colour.

And for the hair about the forehead, thro' which the skin is seen, it must be first formed with the colour thereof, and that of the carnation, working and shadowing with one and the other, as if you designed  
to

to paint none. Then form it, and finish with bistre. The lights are to be heightened as the other. Grey hair is dead-coloured with white, black, and bistre, and finished with the same colour, but deeper; heightening the bright and clear parts of the hair, as well as those of the eye-brows and the beard, with white and very pale blue, after having formed them as the others, with the colour of the flesh or skin; and finish with bistre.

But the most important thing is to soften one's work; to blend the tints in one another, as well as the beard and the hair about the forehead, with the other hair and the carnation; taking especial care not to work rough and dry; and that the traces, turnings and windings of the carnation, or naked parts, be not interfect. You must likewise accustom yourself to put white in your colours only in proportion as you work lighter or darker: for the colour you use the second time must be always a little stronger and deeper than the first, unless it be for softening.

Different colourings are easily made, by putting more or less of red, or blue, or yellow, or bistre, whether for the dead-colouring, or for the finishing. That for women ought to be bluish; that for children a little red; and both fresh and florid. That for men ought to be yellowish; especially when they are old.

To make a colouring of death, there must be a first lay of white and ornament, or a very pale ochre: dead-colour with vermilion, and lake, instead of carmine, and a good deal of white; and afterwards work over it with a green mixture, in which there is more blue than any other colour, to the end the flesh may be livid and of a purple colour. The tints are done the same way as in another colouring; but there must be a great many more blue than yellow ones, especially upon the parts which fly from the sight, and about the eyes; and the last are only to be upon the parts which rise, and come nearer the eye. They are made to die away in one another, according to the ordinary manner; sometimes with very pale blue, and sometimes with ochre and white, and a little vermilion; softening the whole together. The parts and contours must be rounded with the same colours. The mouth is to be, in a manner, of a quite violet. It is dead-coloured, however, with a little vermilion, ochre, and white; but finished with lake and blue: and to give it the deep strokes, they take bistre and lake; with which they likewise do the same to the eyes, the nose, and the ears. If it is a crucifix, or some martyr, upon whom blood is to be seen, after the finishing the carnation, form it with vermilion, and finish it with carmine, making in the drops of blood a little bright reflecting spark, to round them. For the crown of thorns, make a lay of sea-green and masticot; shadow it with bistre and green; and heighten the clear and light parts with masticot.

Iron is formed, or first laid, with indigo, a little black and white; and finished with pure indigo, heightening it with white.

For painting fire and flames, the lights are done with masticot and ornament; and for the shades, they mix vermilion and carmine.

A smoke is done with black, indigo and white, and sometimes with bistre; one may likewise add vermi-

lion or ochre, according to the colour it is to be of.

Pearls are painted by putting a lay of white, and a little blue: they are shadowed and rounded with the same colour, deeper: a small white dot is made almost in the middle, on the side of the light; and on the other side, between the shadow and the edge of the pearl, they give a touch with masticot, to make the reflection; and under the pearls is made a little shadow of the colour of the ground they are upon.

Diamonds are done with pure black; then they heighten them with little touches of white on the side of the light. It is the same thing for any other jewels you have a mind to paint: there is nothing to be done but to change the colour.

For making a figure of gold, put a lay of shell-gold, and shadow it with gall-stone. Silver is done the same way; excepting that it must be shadowed with indigo.

One great means to acquire a perfection in the art, is to copy excellent originals. We enjoy with pleasure and tranquillity the labour and pains of others. But a man must copy a great number before he is able to produce as fine effects; and it is better to be a good copier than a bad author.

### SECT. VI. Of Landscapes.

IN the first first place, after having ordered the economy of your landscape as of your other pieces, you must form the nearest grounds or lands, when they are to appear dark, with sap or lily-green, bistre, and a little verditer, to give a body to your colour; then dot with this mixture, but a little darker, adding sometimes a little black to it.

For such pieces of ground as the light falls upon, and which are therefore clear and bright, make a lay of ochre and white: then shadow and finish with bistre. In some they mix a little green, particularly for shadowing and finishing.

There are sometimes upon the fore-part certain reddish lands; which are dead-coloured with brown-red, white, and a little green; and finished with the same, putting a little more green in them.

For the making of grass and leaves upon the foreground, you must, when that is finished, form with sea-green, or verditer, and a little white; and for those that are yellowish, mix masticot. Afterwards shadow them with lily-green, or bistre and gall-stone, if you would have them appear withered.

The grounds or lands at a little distance, are formed with verditer, and shadowed and finished with sap-green, adding bistre for some of the touches here and there.

Such as are at a greater distance, are done with sea-green and a little blue; and shadowed with verditer.

In a word, the farther they go, the more bluish they are to be made; and the farthest distances ought to be of ultramarine and white; mixing in some places small touches of vermilion.

Water is painted with indigo and white, and shadowed with the same colour, but deeper; and to finish it, instead of dotting, they do nothing but make strokes and traces without crossing; giving them the same turn with the waves, when there are any. Sometimes a little green must be mixed in certain places,

and

and the light and clear parts heightened with pure white, particularly where the water foams.

Rocks are dead-coloured like buildings of stone; excepting that a little green is mixed for forming and shadowing them. Blue and yellow tints are made upon them, and lost with the rest in finishing. And when there are small branches, with leaves, moss, or grass, when all is finished, they are to be raised at top with green and masticot. They may be made yellow, green, and reddish, for appearing dry, in the same manner as on the ground. Rocks are dotted as the rest; and the farther they are off, the more greyish they are made.

Cattles, old houses, and other buildings of stone and wood, are done in the manner abovementioned; speaking of those things, when they are upon the first lines. But when you would have them appear at a distance, you must mix brown-red and vermilion, with much white; and shadow very tenderly with this mixture; and the farther they are off, the weaker are the strokes to be for the preparations. If they are covered with slate, it is to be made bluer than the rest.

Trees are not done till the sky be finished; one may, nevertheless, spare the places of them when they contain a good number: and however it be, such as come near the eye, are to be dead-coloured with verditer, mixing sometimes ochre; and shadowed with the same colours, adding, lily-green. Afterwards you must work leaves upon them by dotting without crossing: for this must be done with small longish dots, of a darker colour, and pretty full of it, which must be conducted on the side the branches go, by little tufts of a little darker colour. Then heighten the lights with verditer or sea-green, and masticot, making leaves in the same manner: and when there are dry branches or leaves, they are dead-coloured with brown-red or gall-stone, with white; and finished with gall-stone, without white, or with bistre.

The trunks of trees are to be dead-coloured with ochre, white, and a little green, for the light and clear parts; and for the dark, they mix black, adding bistre and green for shadowing one and the other. Blue and yellow tints are likewise made upon them, and little touches given here and there with white and masticot; such as you ordinarily see upon the bark of trees.

The branches which appear among the leaves are done with ochre, verditer, and white; or with bistre and white, according to the light they are placed in. They must be shadowed with bistre and lily-green.

Trees, which are at a little distance, are dead-coloured with verditer and sea-green; and are shadowed and finished with the same colours, mixed with lily-green. When there are some which appear yellowish, lay with ochre and white, and finish with gall-stone.

For such as are in the distances and remote views, you must dead-colour with sea-green; with which, for finishing, you must mix ultramarine. Heighten the lights of one and the other with masticot, by small disjointed leaves.

It is the most difficult part of landscape, in manner of miniature, to leaf a tree well. To learn, and break one's hand to it a little, the way is to copy good ones; for the manner of touching them is singular,

and cannot be acquired but by working upon trees themselves; about which you must observe to make little boughs, which must be leafed, especially such as are below and towards the sky.

And generally, let your landscapes be coloured in a handsome manner, and full of nature and truth; for it is that which gives them all their beauty.

#### SECT. VII. Of Flowers.

It is an agreeable thing to paint flowers, not only on account of the splendour of their different colours, but also by reason of the little time and pains that are bestowed in trimming them. There is nothing but delight in it; and, in a manner, no application. You may and bungle a face, if you make one eye higher than another; a small nose with a large mouth; and so of other parts. But the fears of these disproportions constrain not the mind at all in flower-painting; for unless they be very remarkable, they spoil nothing. For this reason most persons of quality, who divert themselves with painting, keep to flowers. Nevertheless, you must apply yourself to copy justly: and for this part of miniature, as for the rest, we refer you to nature, for she is your best model. Work, then, after natural flowers; and look for the tints and different colours of them upon your pallet: a little eye will make you find them easily; and to facilitate this to you at the first, we shall, in the continuance of our design, shew the manner of painting some; for natural flowers are not always to be had; and one is often obliged to work after prints, where nothing is seen but graving.

It is a general rule, that flowers are designed and laid like other figures; but the manner of forming and finishing them is different: for they are first formed only by large strokes and traces, which you must turn at the first the way the small ones are to go, with which you finish; this turning aiding much thereto. And for finishing them, instead of hatching or dotting, you draw small strokes very fine, and very close to one another, without crossing; repassing several times, till your dark and your clear parts have all the force you would give them.

Of Roses.—After making your first sketch, draw with carmine the red rose, and apply a very pale lay of carmine and white. Then form the shades with the same colour, putting less white in it: and lastly, with pure carmine, but very bright and clear at the first; fortifying it more and more as you proceed in your work, and according to the darkness of the shades. This is done by large strokes. Then finish; working upon it with the same colour by little strokes, which you must make go the same way with those of the graving, if it be a print you copy; or the way the leaves of the rose turn, if you copy after a painting, or after nature; losing the dark in the clear parts, and heightening the greatest lights, and the brightest or most lightsome leaves, with white and a little carmine. You must always make the hearts of roses, and the side of the shadow darker than the rest; and mix a little indigo for shadowing the first leaves, particularly when the roses are blown, to make them seem faded. The seed is dead-coloured with gamboge; with which a little sap-green is mixed for shadowing. Roses streaked with several colours, ought to be paler than

Of  
Flowers.Of  
Flowers.

than others, that the mixture of colours may be better seen; which are done with carmine; a little darker in the shades, and very clear in the lights; always hatching by strokes. For white roses you must put a lay of white, and form and finish them as the red; but with black, white, and a little bistre; and make the feed a little yellower. Yellow roses are done by putting in every part a lay of masticot, and shadowing them with gamboge, gall-stone, and bistre; heightening the clear and light places with masticot and white.

The files, the leaves, and the buds of all sorts of roses are formed with verditer, with which is mixed a little masticot and gamboge; and for shadowing them, they add sap-green, putting less of the other colours when the shades are deep. The outside of the leaves ought to be bluer than the inside: wherefore it must be dead-coloured with sea-green, and sap-green mixed with that for shadowing, making the veins or fibres on this side clearer than the ground, and those on the other side darker. The prickles which are upon the files and buds of roses, are done with little touches of carmine, which are made to go every way; and for those that are upon the stalks, they are formed with verditer and carmine, and shadowed with carmine and bistre; making the bottom of the stalks more reddish than the top; *i. e.* you must mix with the green, carmine and pure bistre.

Of Tulips.—As there is an infinity of tulips, different from one another, one cannot pretend to mention the colours with which they are all done. We will only touch upon the handsomest, called *freaked*: and these freaks are dead-coloured, with very clear carmine in some places, and with darker in others; finishing with the same colour by little strokes, which must be carried the same way with the freaks. And in others is put first a lay of vermilion. Then they form them by mixing carmine, and finish them with pure carmine. In some they put Florence-lake over the vermilion instead of carmine. Some are done with lake and carmine mixed together, and with lake alone, or with white and lake for the first forming; whether it be rose-pink or Florence-lake. There are some of a purple colour, which are formed with ultramarine, carmine, or lake, sometimes bluer and sometimes redder. The manner of doing both one and the other is the same: there is no difference but in the colours. You must, in certain places, as between the freaks of vermilion, carmine, or lake, sometimes put blue made of ultramarine and white, and sometimes a very bright purple, which is finished by strokes as the rest, and lost with the freaks. There are some likewise that have fallow teints, that are made with lake, bistre, and ochre, according as they are: but this is only in fine and rare tulips, and not in the common ones. For shadowing the bottom of them, they ordinarily take indigo and white for such whose freaks are of carmine. For such as are of lake, they take black and white; with which, in some, bistre is mixed, and in others green. Some are likewise to be shadowed with gamboge and umber, and always by strokes and traces, that turn as the leaves turn. Other tulips are likewise done, called *bordered*; that is to say, the tulip is not freaked but on the edges of the leaves, where there is a border. It is white in the purple; red in the yellow; yellow in the red; and red in the

white. The purple is laid with ultramarine, carmine, and white; shadowing and finishing it with this mixture. The border is spared; that is to say, let only a light lay of white be put there, and let it be shadowed with very bright indigo. The yellow is formed with gamboge, and shadowed with the same colour, mixing ochre and umber or bistre with it. The border is laid with vermilion, and finished with a very small matter of carmine. The red is formed with vermilion, and finished with the same colour, mixing carmine or lake with it. The bottom and the border are done with gamboge; and for finishing, they add gall-stone and umber, or bistre. The white is shadowed with black, blue, and white. Indian ink is very proper for this. The shadowings of it are very tender. It produces alone the effect of blue and white, mixed with the other black. The border of this white tulip is done with carmine. In all these sorts of tulips, they leave a nerve or finew in the middle of the leaves that are brighter than the rest; and the borders are drowned at the bottom by small traces, turning crosswise; for they must not appear cut and separated, as the streaked or party-coloured. They make them likewise of several other colours.—When they happen to be such whose bottoms on the inside are black, as it were, they form and finish them with indigo, as also the feed about the nozzle or stalk. And if the bottom is yellow, it is formed with gamboge, and finished by adding umber or bistre. The leaves and the stalks of tulips are ordinarily formed with sea-green, and shadowed and finished with lily-green, by large traces all along the leaves. Some may likewise be done with verditer, mixing masticot with it, and shadowed with sap-green, that the green of the shades may be yellower.

The ANEMONY, or *Wind-flower*.—There are several sorts of them, as well double as single. The last are ordinarily without freaks. Some are made of a purple colour, with purple and white, shadowing them with the same colour; some redder, others bluer; sometimes very pale, and sometimes very dark. Others are formed with lake and white, and finished with the same, putting less white; some without any white at all. Others are formed with vermilion, and shadowed with the same colour, adding carmine. We see likewise white ones, and some of a citron colour. The last are laid with masticot; and one and the other shadowed and finished sometimes with vermilion, and sometimes with very brown lake, especially near the feed, at the bottom; which is often likewise of a blackish colour, that is done with indigo, or black and blue, mixing for some a little bistre; and always working by very fine strokes and traces, and losing the lights in the shades. There are others that are brighter and clearer at the bottom than any where else; and sometimes they are perfectly white there, though the rest of the flower be dark. The feed of all these anemones is done with indigo and black, with a very little white, and shadowed with indigo; and in some it is raised with masticot. The double anemones are of several colours. The handsomest have their large leaves freaked. Some are done, that is, the freaked or party-coloured, with vermilion, to which carmine is added for the finishing; shadowing the rest of the leaves with indigo; and for the small

leaves within, a lay is put of vermilion and white, and they are shadowed with vermilion mixed with carmine, mixing here and there some stronger touches, especially in the heart of the flower, next the great leaves on the side of the shadow. They finish with carmine, by little strokes and traces, turning the same way with the mixed or party-colours, and the leaves. They form and finish the streaks or party-colours of some others, as well as the small leaves, with pure carmine; leaving, nevertheless, in the middle of the last, a little circle, in which is laid dark purple, which is lost with the rest. And when all is finished, they give some touches with this same colour round about the small leaves, especially on the side of the shadow; drowning them with the large ones, the remainder of which is shadowed either with indigo or black. In some, the small leaves are done with lake or purple, though the party-colours of the large ones be done with carmine. There are others, whose mixed colours are done with carmine, in the middle of most of the large leaves; putting in some places vermilion underneath, and losing these colours with the shadows of the bottom; which are done with indigo and white. The small leaves are laid with masticot, and shadowed with very dark carmine on the side of the shade, and with very clear on the side of the light, leaving there in a manner pure masticot, and giving only some little touches with orpiment and carmine, to separate the leaves, which may be shadowed sometimes with a very little pale-green. There are double anemones painted all red, and all purple. The first are formed with vermilion and carmine, in a manner without white, and shadowed with pure carmine, well gummed, that they may be very dark. Purple anemones are laid with purple and white, and finished with white. In a word, there are double anemones, as there are single ones, of all colours; and they are done in the same manner. The green of one and the other is verditer; with which masticot is mixed for forming. It is shadowed and finished with sap-green. The files of them are a little reddish; wherefore they are shadowed with carmine mixed with bistre, and sometimes with green, after having laid them with masticot.

**The CARNATION and the PINK.**—It is with pinks and carnations as with anemones and tulips; that is, there are some mixt-coloured, and others of one single colour. The first are streaked and diversified sometimes with vermilion and carmine, sometimes with pure lake, or with white; some streaks very dark, and others very pale; sometimes by little streaks and diversifications, and sometimes by large ones. Their bottoms are ordinarily shadowed with indigo and white. There are pinks of a very pale flesh-colour, and streaked and diversified with another, a little deeper, made with vermilion and lake. Others, which are of lake and white, are shadowed and streaked without white. Others all red, which are done with vermilion and carmine, as dark as possible. Others all of lake. And lastly, there are others, wherein nature or fancy is the rule. The green of one and the other is sea-green, shadowed with lily-green or sap-green.

**The RED-LILY.**—It is laid with red-lead, formed with vermilion, and in the deepest of the shades with carmine; and finished with the same colour by strokes

and traces, turning as the leaves turn. The clear and light parts are heightened with red-lead and white. The feed is done with vermilion and carmine. The green parts are done with verditer, shadowed with lily or sap-green.

**The DAY-LILY.**—There are three sorts of them:

1. The gridelin, a little red;
2. The gridelin, very pale; and,
3. The white.

For the first they put a lay of lake and white, and shadow and finish with the same colour deeper; mixing a little black to deaden it, especially in the darkest places.

The second are laid with white, mixed with a very little lake and vermilion, in such a manner that they two last colours are hardly seen. Afterwards they shadow with black and a little lake, working redder in the middle of the leaves, next the stalks; which ought to be, as also the feed, of the same colour, particularly towards the top; and at the bottom a little greener.

The file of the feed is laid with masticot, and shadowed with sap-green.

The other day-lilies are done by putting a lay of pure white, and shadowing and finishing with black and white.

The stalks of these last, and the greens of them all, are done with sea-green, and shadowed with sap-green.

**The HYACINTH, or Purple-flower.**—There are four sorts of them.

- The blue, a little dark;
- Others paler;
- The gridelin;
- And the white.

The first are laid with ultramarine and white; and shadowed and finished with less white. Others are laid and shadowed with pale blue. The gridelins are formed with lake and white, and a very small matter of ultramarine; and finished with the same colour a little deeper. For the last they put a lay of white; then they shadow them with black, with a little white; and finish them all by strokes and traces, following the turnings and windings of the leaves. The green and the stalks of such as are blue, are done with sea and lily-green very dark; and in the stalks of the first may be mixed a little carmine, to make them reddish. The stalks of the two others, as also the green, are formed with verditer and masticot, and shadowed with sap-green.

**The PIONY.**—A lay of Venice-lake and white must be put on all parts, pretty strong; then shadow with less white, and with none at all in the darkest places; after which finish with the same colour by traces, turning them as for the rose; gumming it very much in the deepest of the shades; and raising the lights and the edges of the most lightome leaves with white and a little lake. Little veins are likewise made, which go like the strokes in hatching, but are more visible. The green of this flower is done with sea-green, and shadowed with sap-green.

**COWSLIPS.**—They are of four or five colours. There are some of a very pale purple.

The gridelin. The white and the yellow.

The purple is done with ultramarine, carmine, and white;



white; putting lefs white for shadowing. The gride-  
lin is laid with Venice-lake, and a very small matter  
of ultramarine, with much white; and shadowed with  
the fame colour deeper. For the white, a lay of  
white muft be put; and they muft be shadowed with  
black and white; and finished, as the others, by tra-  
ces, or strokes. The heart of thefe cowflips is  
done with malficot in the fhape of a ftar, which is  
shadowed with gamboge, making a little circle in the  
middle with fap-green. The yellow are laid with  
malficot, and shadowed with gamboge and umber.  
The ftiles, the leaves, and the buds, are formed with  
verditer, mixed with a little malficot, and finished  
with fap-green; making the fibres or veins, which ap-  
pear upon the leaves, with this fame colour; and  
heightening the lights of the largelt with malficot.

The *RANUNCULUS*, or *Crow-foot*.—There are fe-  
veral forts of them: the fineft are the orange-coloured.  
For the firft, they put a lay of vermilion, with a very  
small matter of gamboge; and add carmine for sha-  
dowing; finishing it with this laft colour, and a little  
gall-ftone. In the others may be put Venice-lake,  
inftead of carmine, especially in the heart of the  
flower. The orange-coloured are laid with gamboge,  
and finished with gall-ftone, vermilion, and a little  
carmine; leaving fome little yellow ftreaks. The  
green of the ftalks is done with verditer and very pale  
malficot; mixing lily-green to shadow them. That  
of the leaves is a little darker.

The *CROCUS*.—There are of two colours.

Yellow and purple. The yellow are formed with  
malficot and gall-ftone, and shadowed with gamboge  
and gall-ftone: after which, upon each leaf, on the  
outfide, are made three ftreaks, feperate from one  
another, with bitre and pure lake; which are loft,  
by little traces, in the bottom. The outfide of the  
leaves is left all yellow.—The purple are laid with car-  
mine, mixed with a little ultramarine, and very pale  
white. They are formed and finished with lefs white;  
making likewife, in fome, purple ftripes or ftreaks,  
very dark, as in the yellow; and in others, only fmall  
veins. The feed of both is yellow; and is done with  
orpiment and gall-ftone. For the ftiles, they put a  
lay of white, and shadow with black, mixed with a  
little green. The green of this flower is formed  
with very pale verditer, and shadowed with fap-  
green.

The *IRIS*.—The Perfian iris is done by putting,  
for the infide-leaves, a lay of white, and shadowing  
them with indigo and green together, leaving a little  
white feperation in the middle of each leaf; and for  
thofe on the outfide, they put in the fame place a lay  
of malficot, which is shadowed with gall-ftone and  
orpiment; making little dark and loughifh dots over  
all the leaf, at a fmall diftance from one another. And  
at the end of each are made large ftirains, with bitre  
and lake in fome, and in others with pure indigo,  
but very black. The reft, and the outfide of the  
leaves, are shadowed with black. The green is formed  
with fea-green, and very pale malficot, and shadowed  
with fap-green. The Sufian iris is laid with purple  
and white, putting a little more carmine than ul-  
tramarine; and for the shades, especially in the middle  
leaves, they put lefs white; and, on the contrary,  
more ultramarine than carmine; making the veins of

this very colour, and leaving in the middle of the in-  
fide leaves a little yellow finew. There are others  
which have this very finew in the firft leaves; the end  
of which only is bluer than the reft. Others are sha-  
dowed and finished with the fame purple, redder:  
They have alfo the middle finew on the outfide-leaves;  
but white and shadowed with indigo. There are like-  
wife yellow ones; which are done by putting a lay of  
malficot and orpiment; shadowing them with gall-  
ftone, and making the veins upon the leaves with  
bitre. The green of one and the other is done with  
fea-green, mixing a little malficot for the ftiles. They  
are shadowed with fap-green.

The *JASMIN*.—It is done with a lay of white, and  
shadowed with black and white; and for the outfide  
of the leaves, they mix a little bitre; making the half  
of each, on this fide, a little reddifh with carmine.

The *TUBEROSE*.—For the doing of this, they make  
a lay of white, and shadow with black, with a little  
bitre in fome places; and for the outfide of the leaves,  
they mix a little carmine, to give them a reddifh taint,  
particularly upon the extremities. The feed is done  
with malficot, and shadowed with fap-green. The  
green of it is laid with verditer, and shadowed with  
fap-green.

The *HELLEBORE*.—The flower of hellebore is done  
almoft in the fame manner; that is, let it be laid with  
white, and shadowed with black and bitre, making  
the outfide of the leaves a little reddifh here and there.  
The feed is laid with dark green, and raifed with  
malficot. The green of it is foul and rufly, and is  
formed with verditer, malficot, and bitre; and finished  
with fap-green and bitre.

The *WHITE LILY*.—It is laid with white, and  
shadowed with black and white. The feed is done  
with orpiment and gall-ftone. And the green is done  
as in the tuberofe.

The *SNOW-DROP*.—It is formed and finished as the  
white lily. The feed is laid with malficot, and sha-  
dowed with gall-ftone. And the green is done with  
fea and fap-green.

The *JONQUIL*.—It is laid with malficot and gall-  
ftone, and finished with gamboge and gall-ftone. The  
green is formed with fea-green, and shadowed with  
fap-green.

The *DAFFODIL*.—All daffodils, the yellow, the  
double, and the fingle, are done by putting a lay of  
malficot: they are formed with gamboge, and finish-  
ed by adding umber and bitre; excepting the bell in  
the middle, which is done with orpiment and gall-  
ftone, bordered or edged with vermilion and carmine.  
The white are laid with white, and shadowed with  
black and white; excepting the cup or bell, which is  
done with malficot and gamboge. The green is fea-  
green, shadowed with fap-green.

The *MARIGOLD*.—It is done by putting a lay of  
malficot, and then one of gamboge; shadowing it  
with this very colour, after vermilion is mixed with  
it: and for finishing, they add gall-ftone and a little  
carmine. The green is done with verditer, shadowed  
with fap-green.

The *AUSTRIAN ROSE*.—For making the Indian  
rofe, they put a lay of malficot, and another of gam-  
boge. Then they form it, mixing gall-ftone; and  
finifh it with the laft colour, adding bitre and a very  
fmal

small matter of carmine in the deeper shades.

**THE INDIAN PINK, or French Marigold.**—It is done by putting a lay of gamboge; shadowing it with this colour, after you have mixed a good deal of carmine and gall-stone with it; and leaving about the leaves a little yellow border of gamboge, very clear in the lights, and darker in the shades. The feed is shadowed with bistre. The green as well of the rose as the pink, is formed with verditer, and finished with sap-green.

**THE SUN-FLOWER.**—It is formed with masticot and gamboge, and finished with gall-stone and bistre. The green is laid with verditer and masticot, and shadowed with sap-green.

**THE PASSION-FLOWER.**—It is done as the rose, and the green of the leaves likewife; but the veins are done with a darker green.

**POETICAL PINKS and SWEET-WILLIAMS.**—They are done by putting a lay of lake and white; shadowing them with pure lake, with a little carmine for the last; which are afterwards dotted on all parts with little round dots, separate from one another; and the threads in the middle are raised with white. The green of them are sea-green, which is finished with sap-green.

**THE SCABIOUS.**—There are two sorts of scabious, the red and the purple. The leaves of the first are laid with Florence-lake, in which there is a little white; and shadowed without white: and for the middle, which is a great boss or hulk in which the feed lies, it is formed and finished with pure lake, with a little ultramarine or indigo to make it darker. Then they make little white longish dots over it, at a pretty distance from one another, clearer in the light than in the shade, making them go every way. The other is done by putting a lay of very pale purple, as well upon the leaves as the boss in the middle; shadowing both with the same colour, a little deeper: and instead of little white touches from the feed, they make them purple; and about each grain they make out a little circle, and this over the whole boss or hulk in the middle. The green is formed with verditer and masticot, and shadowed with sap-green.

**THE SWORD or Day-lily.**—It is laid with Florence-lake and very pale white; formed and finished with pure lake, very clear and bright in some places, and very dark in others; mixing even bistre in the thickest of the shades. The green is verditer, shadowed with sap-green.

**HEPATIC, or Liverwort.**—There is red and blue. The last is done by putting on all parts a lay of ultramarine, white, and a little carmine or lake; shadowing the inside of the leaves with this mixture, but deeper; excepting those of the first rank; for which, and for the outside of every one of them, they add indigo and white, that the colour may be paler, and not so fine. The red is laid with lake-columbine and very pale white; and finished with less white. The green is done with verditer, masticot, and a little bistre; and shadowed with sap-green, and a little bistre, especially on the outside of the leaves.

**THE POMEGRANATE.**—The flower of the pomegranate is laid with red-lead; shadowed with vermilion and carmine; and finished with this last colour. The green is laid with verditer and masticot, and shadowed with sap-green.

**THE Flower of the Indian BEAN.**—It is done with a lay of Levant-lake and white; shadowing the middle leaves with pure lake; and adding a little ultramarine for the others. The green is verditer, shadowed with sap-green.

**THE COLUMBINE.**—There are columbines of several colours: the most common are the purple, the gridelin, and the red. For the purple, they lay with ultramarine, carmine, and white; and shadow with this mixture, deeper. The gridelin are done the same way, putting a great deal less ultramarine than carmine. The red are done with lake and white, finishing with less white. There are some mixed flowers of this kind, of several colours; which must be formed and finished as the others, but paler, making the mixtures of a little darker colour.

**THE LARK'S HEEL.**—There are of different colours, and of mixed colours: the most common are the purple, the gridelin, and the red; which are done as the columbines.

**VIOLETS and PANSIES.**—Violets and pansies are done the same way; excepting that in the last the two middle leaves are bluer than the others, that is, the borders or edges; for the inside of them is yellow; and there little black veins are made, which take their beginning from the heart of the flower, and die away towards the middle.

**THE MUSCIPULA, or Catch-fly.**—There are two sorts of it, the white and the red; the last is laid with lake and white, with a little vermilion, and finished with pure lake. As for the knot or nozzle of the leaves, it is formed with white and a very small matter of vermilion, mixing bistre, or gall-stone, to finish it. The leaves of the white are laid with white; adding bistre and masticot upon the knots, which are shadowed with pure bistre, and the leaves with black and white. The green of all these flowers is done with verditer and masticot, and shadowed with sap-green.

**THE CROWN IMPERIAL.**—There are of two colours, the yellow and the red. The first is done by putting a lay of orpiment, and shadowing it with gall-stone and orpiment, with a little vermilion. The other is laid with orpiment and vermilion, and shadowed with gall-stone and vermilion; making the beginning of the leaves next the stile, with lake and bistre, very dark; and veins with this mixture, both in one and the other, all along the leaves. The green is done with verditer and masticot, shadowed with sap-green and gamboge.

**THE CYCLAMEN, or Sow-bread.**—The red is laid with carmine, a little ultramarine, and much white; and finished with the same colour, deeper; putting, in a manner, only carmine in the middle of the leaves, next the heart, and in the rest add a little more ultramarine. The other is laid with white, and shadowed with black. The stalks of one and the other ought to be a little reddish; and the green, verditer and sap-green.

**THE GILLIFLOWER.**—There are several sorts of gilliflowers; the white, the yellow, the purple, the red, and the mixed, of various colours. The white are laid with white, and shadowed with black, and with a little indigo in the heart of the leaves. The yellow, with masticot, gamboge, and gall-stone. The purple are formed with purple and white; and finished with less white;

Of  
Fruits, &c.

white; making the colour brighter in the heat, and even a little yellowish. The red with lake and white; finishing them with white. The mixed-coloured are laid with white, and the mixtures are sometimes made with purple, in which there is much ultramarine; others again, in which there is more carmine. Sometimes they are of lake, and sometimes of carmine. Some are done with white, and others without white; shadowing the rest of the leaves with indigo. The feed of all is formed with verditer and malicot, and finished with sap-green. The leaves and files are laid with the same green, mixing sap-green to finish them.

FRUITS, fishes, serpents, and all sorts of reptiles, are to be touched in the same manner as the figures of men are; that is, hatched or dotted.

Birds and all other animals are done like flowers, by strokes, or traces.

Never make use, for any of these things, of white-lead. It is only proper in oil. It blacks like ink, when only tempered with gum; especially if you set your work in a moist place, or where perfumes are. Cerufs of Venice is as fine, and of as pure a white. Be not sparing in the use of this, especially in forming or dead-colouring; and let it enter into all your mixtures, in order to give them a certain body, which will render your work glueish, and make it appear soft, plump, and strong.

The taste of painters is, nevertheless, different in this point. Some use a little of it, and others none at all. But the manner of the last is meagre and dry. Others use a great deal; and doubts it is the best method and most followed among skilful persons: for besides that

it is speedy, one may by the use of it copy all sorts of pictures; which would be almost impossible otherwise; notwithstanding the contrary opinion of some, who say, that in miniature we cannot give the force and all the different tints we see in pieces in oil. But this is not true, at least of good painters; and effects prove it pretty plainly: for we see figures, landscapes, pictures, and every thing else in miniature, touched in as grand, as true, and as noble a manner, (though more tender and delicate), as they are in oil.

However, painting in oil has its advantages; were they only these, that it exhibits more work, and takes up less time. It is better defended likewise against the injuries of time; and the right of birth must be granted it, and the glory of antiquity.

But miniature likewise has its advantages; and without repeating such as have been mentioned already, it is neater and more commodious. You may easily carry all your implements in your pockets, and work when and wherever you please, without such a number of preparations. You may quit and resume it when and as often as you will; which is not done in the other; in which one is rarely to work dry.

To conclude: In the art of painting, excellence does not depend upon the greatness of the subject, but upon the manner in which it is handled. Some catch the airs of a face well; others succeed better in landscapes: some work in little, who cannot do it in large: some are skilled in colours, who know little of design: others, lastly, have only a genius for flowers: and even the Bassans got themselves a fame for animals; which they touched in a very fine manner, and better than any thing else.

## M I N

## M I N

Minium.

Minim  
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Minium.

MINIM, in music, a note equal to two crotchets, or half a semibreve. See Music.

MINIMS, a religious order in the church of Rome, founded by St Francis de Paula, towards the end of the 15th century. Their habit is a coarse black woollen stuff, with a woollen girdle, of the same colour, tied in five knots. They are not permitted to quit their habit and girdle night nor day. Formerly they went bare-footed, but are now allowed the use of shoes.

MINIMUM, in the higher geometry, the least quantity attainable in a given case.

MINISTER, a person who preaches, performs religious worship in public, administers the sacraments, &c.

MINISTER of *States*, a person to whom the prince intrusts the administration of government. See COUNSEL.

*Foreign MINISTER*, is a person sent into a foreign country, to manage the affairs of his province, or of the state to which he belongs. Of these there are two kinds: those of the first rank are ambassadors, and envoys extraordinary, who represent the persons of their sovereigns; the ministers of the second rank are the ordinary residents.

MINIUM, or RED-LEAD. See CHEMISTRY, n<sup>o</sup> 402.

The general method of preparing that colour is there described; but the following more accurate and particular one hath appeared in the last edition of the

Chemical Dictionary. "The furnace in which minium is made is of the reverberatory kind, with two fire-places at the ends; each fire-place being separated from the area, or body of the furnace, by a wall 12 inches high. The fire-places are 15 inches broad, and their length is equal to the breadth of the whole furnace, which is about eight or nine feet. The length of the area from one fire-place to the other is 9 or 10 feet. The quantity of lead used in one operation is about 1500 pounds, of which nine parts are lead obtained from furnaces where the ore is smelted, and one part is lead extracted from the scoria which is formed in smelting the ore. This latter kind is said to be necessary, as the former could not alone be reduced into powder. All the lead is at once put into the area, the bottom of which is level. The calx, as fast as it is formed, is drawn to one side by means of a rake suspended by a chain before the mouth of the furnace. In four or five hours the whole quantity of the lead is calcined, or, if any pieces remain uncalcined, they are separated, and kept for the next operation. The heat employed is that of a cherry-red; and the fire-places and mouth are kept open, that the air may accelerate the calcination. The powder or calx is to be frequently stirred to prevent its concreting; and when this operation has been continued about 24 hours, the matter is taken out of the furnace, and laid on a flat pavement. The cold water is thrown on it, to give it weight, as the workmen say; but rather, as some think, to make it friable. It is then to be ground in a mill, and the finer.

Minor.  
Minorca.

finer part is separated by washing, while the coarser part, reserved for some following operation, is to be placed at the mouth of the furnace in order to retain the melted lead. The fine powder, which is now of a yellow colour, is again put into the same or a similar furnace, and exposed to a very moderate fire from 36 to 48 hours; during which time it is stirred frequently to prevent its concreting; and the powder gradually acquires its proper red colour. The minium is then to be taken out of the furnace, cooled, and sifted thro' an iron sieve placed in a cask."

MINOR, in law. See LAW, n° clxi.

MINOR, in logic, the second proposition of a regular syllogism. See LOGIC.

MINORCA, an island of the Mediterranean, situated between 39 and 40 degrees of North Latitude, and near four degrees of East Longitude. It is about 33 miles in length from north-west to south-east, in breadth from eight to twelve, but in general about ten miles; so that in size it may nearly equal the county of Huntingdon or Bedfordshire. The form is very irregular; and the coasts are much indented by the sea, which forms a great number of little creeks and inlets, some of which might be very advantageous.

This island is one of those called by the ancient Romans *Baleares*, which arose from the dexterity of the inhabitants in using the sling. It fell under the power of the Romans, afterwards of the northern barbarians, who destroyed that empire. From them it was taken by the Arabs, who were subdued by the king of Majorca, and he by the king of Spain. The English subdued it in 1708, and the French in the late war; but it was restored to Britain by the treaty of Paris in 1763.

The air of this island is much more clear and pure than in Britain; being seldom darkened with thick fogs: yet the low valleys are not free from mists and unwholesome vapours; and in windy weather the spray of the sea is driven over the whole island. Hence it happens that utensils of brass or iron are extremely susceptible of rust, in spite of all endeavours to preserve them; and household furniture becomes mouldy. The summers are dry, clear, calm, and excessively hot; the autumns moist, warm, and unequal; at one time perfectly serene, at another cloudy and tempestuous. During the winter there are sometimes violent storms, though neither frequent nor of long continuance; and whenever they cease, the weather returns to its usual serenity. The spring is always variable, but resembles the winter more than the summer. The changes of heat and cold are neither so great nor so sudden in this climate as in many others. In the compass of a year, the thermometer seldom rises much above the 80th, or falls below the 48th degree. In summer there is scarcely ever a difference of four or five degrees between the heat of the air at noon and at night; and in winter the variation is still less considerable. But this must be understood of a thermometer shaded from the influence of the solar beams; for if exposed to them it will often rise 12, 14, or 16 degrees higher than what we have mentioned; and in other seasons the difference between the heat of the air in the sun and in the shade is much greater. Yet, even in the dog-days, the heat of the atmosphere, at least in open places, seldom surpasses that of human blood. The

Minorca.

winds are very boisterous about the equinoxes, and sometimes during during the winter. At other times they are generally moderate, and, according to the observations of seamen, they rarely blow in the same direction near the islands adjacent to the gulph of Lyons as in the open sea. During the summer there is commonly a perfect calm in the mornings and evenings; but the middle of the day is cooled by refreshing breezes which come from the east, and, following the course of the sun, increase gradually till two or three in the afternoon; after which they insensibly die away, as night approaches. This renders the heat of the sun less dangerous and inconvenient; and if these breezes intermit for a day or two, the natives grow languid and inactive from the heat. The northerly winds in general are clear and healthy, dispel the mists, and make a clear blue sky; whilst those which blow from the opposite quarter, render the air warm, moist, and unhealthy. The north wind is superior in power to all the rest; which appears from hence, that the tops of all the trees incline to the south, and the branches on the north side are bare and blasted. The next to it in force is the north-west. Both are frequent towards the close of winter, and in the spring; and, being dry and cold, they shrivel up the leaves of the vegetables, destroy their tender shoots, and are often excessively detrimental to the vineyards and rising corn. The piercing blasts at that season from the north-east, as they are more moist, and more frequently attended with rain, are less prejudicial. The south and south-east winds are by much the most unhealthy. In whatever seasons they blow, the air is foggy, and affects the breathing; but in the summer season they are sultry and suffocating. An excessive dejection of spirits is then a universal complaint; and on exposing the thermometer to the rays of the sun, the mercury has frequently risen above the 100th degree. The west wind is usually drier than the south: the east is cold and blustering in the spring, and sultry in the summer.

The weather in Minorca is generally fair and dry; but when it rains, the showers are heavy, though of short continuance, and they fall most commonly in the night. The sky in summer is clear, and of a beautiful azure, without clouds or rain; but moderate dews descend regularly after sunset. In autumn the weather becomes less serene; whirlwinds and thunder become frequent; and in the night-time lightning, and those meteors called *falling stars*, are very common. Water-spouts also are often seen at that season, and frequently break upon the shore. A sudden alteration in the weather takes place about the autumnal equinox; the skies are darkened with clouds, and the rains fall in such quantities, that the torrents thereby occasioned, pouring down from the hills, tear up trees by the root, carry away cattle, break down fences, and do considerable mischief to the gardens and vineyards. But these anniversary rains are much more violent than laiting; always falling in sudden and heavy showers, with intervals of fair weather. They are accompanied with thunder, lightning, and squalls of wind, most commonly from the north. Hail and snow are often intermixed with the rains which fall in winter and in spring; but the snow, for the most part, dissolves immediately; and ice is here an uncommon

Minorca. mon appearance.

The whole coast of Minorca lies low; and there are only a few hills near the centre, of which the most considerable, named *Toro* by the inhabitants, may be seen at the distance of 12 or 14 leagues from the land. The surface of the island is rough and unequal; and in many places divided by long narrow vales of a considerable depth, called *barrancos* by the natives. They begin towards the middle of the island, and after several windings terminate at the sea. The south-west side is more plain and regular towards the north-east; where the hills are higher, with low, marshy valleys betwixt them, the soil less fruitful, and the whole tract unhealthy to man and beast. Near the towns and villages the fields are well cultivated, and inclosed with stone-walls; but the rest, for the most part, are rocky, or covered with woods and thickets. There are some pools of standing water, but very few rivulets; which is the greatest defect about the island, as the inhabitants have scarcely any wholesome water excepting what is saved from the clouds.

The soil is light, thin, and very stony, with a good deal of sea-salt, and, in some places, of calcareous nitre intermixed. In most places there is so little earth, that the island appears to be but one large irregular rock covered here and there with mould, and an infinite variety of stones. Notwithstanding this, however, it is not only extremely proper for vineyards, but produces more wheat and barley than could at first sight be imagined; and, if the peasants may be credited, it would always yield a quantity of corn and wine sufficient for the natives, did not the violence of the winds, and the excessive drought of the weather, frequently spoil their crops. The fields commonly lie fallow for two years, and are sown the third. About the latter end of winter, or the beginning of spring, they are first broke up; and next autumn, as soon as the rains fall, they are again ploughed and prepared for receiving the proper seeds. The tillage is very easily performed; for a plough so light as to be transported from place to place on the ploughman's shoulder, and to be drawn by an heifer, or an ass sometimes assisted by an hog, is sufficient for opening so thin a soil. The later the harvest happens, the more plentiful it proves. The barley is usually cut down about the 20th of May N. S. and the wheat is reaped in June; so that the whole harvest is commonly got in by midsummer-day. The grain is not threshed with flails as in this country, but trodden out on a smooth piece of rock by oxen and asses, according to the custom of the eastern nations.

The natives of Minorca are commonly lean, thin, and well-built, of a middle stature, and olive complexion; but their character is by no means agreeable. Such is the natural impetuosity of their temper, that the slightest cause provokes them to anger; and they seem to be incapable of forgiving or forgetting an injury. Hence quarrels break out daily, even among neighbours and relations; and family-disputes are transmitted from father to son; and thus, though lawyers and pettifoggers are very numerous in this country, there are still too few for the clients. Both sexes are, by constitution, extremely amorous: they are often betrothed to each other while children, and marry at the age of 14. The women have easy la-

bours, and commonly return in a few days to their usual domestic business; but, left the family should become too numerous for their income, it is a practice among the poorer sort to keep their children at the breast for two or three years, that by this means the mothers may be hindered from breeding.

Bread of the finest wheat-flour, well fermented and well baked, is more than half the diet of people of all ranks. Rice, pulse, vermicelli, herbs and roots from the garden, summer-fruits, pickled olives, and pods of the Guinea pepper, make up almost all the other half; so that scarce a fifth of their whole food is furnished from the animal-kingdom, and of this fish makes by much the most considerable portion. On Fridays, and other fast-days, they abstain entirely from flesh; and during Lent they live altogether on vegetables and fish, excepting Sundays, when they are permitted the use of eggs, cheese, and milk. Most of their dishes are high-seasoned with pepper, cloves, cinnamon, and other spices; and garlic, onions, or leeks, are almost constant ingredients. They eat a great deal of oil, and that none of the sweetest or best flavoured; using it not only with fallads, but also with boiled and fried fish, greens, pulse, &c. instead of butter. A slice of bread soaked in boiled water, with a little oil and salt, is the common breakfast of the peasants, well known by the name of *olagaa*. Their ordinary meals are very frugal, and consist of very little variety; but on festivals and other solemn occasions, their entertainments are to the last degree profuse and extravagant, inasmuch that the bill of fare of a country farmer's wedding-dinner would scarce be credited.

With regard to other matters, the Minorquins are accused of prodigious indolence in the way of business, and neglect of the natural advantages they possess. In the bowels of the earth are iron, copper, and lead-ores, of none of which any use hath been made except the last. A lead-mine was worked to advantage some time ago, and the ore sent into France and Spain for the use of the potteries in those countries. The proprietor discontinued his work on some small discouragement; and indeed it is said, that these people are of all mankind the most easily put out of conceit with an undertaking that does not bring them in mountains of present gain; or that admits of the slightest probability of disappointing their most sanguine expectations: nor will their purse admit of many disappointments; and thus their poverty co-operating with their natural despondence and love of ease, is the principal cause of their backwardness to engage in projects, though ever so promising, for the improvement of their private fortune, and the advantage of the commerce of their country. This lead-ore went under the name of *vernis* among the natives, as it was wholly used by the potters in varnishing and glazing their earthen vessels.

There are few exports of any account, and they are obliged to their neighbours for near one-third of their corn, all their oil, and such a variety of articles of less consideration, that nothing could preserve them from a total bankruptcy, but the English money circulated by the troops, which is exchanged for the daily supplies of provisions, increased by the multiplication of vineyards, the breeding of poultry, and the production of vegetables, in a proportion of

Minorca.

*Minorca.* at least five to one since the island has been in our possession. It will not require many words to enumerate their exports: they make a fort of cheese, little liked by the English, which sells in Italy at a very great price; this, perhaps, to the amount of 800 l. *per annum*. The wool they send abroad may produce 900 l. more. Some wine is exported; and, if we add to its value that of the home-consumption, which has every merit of an export, being nine parts in ten taken off by the troops for ready money, it may well be estimated at 16,000 l. a-year. In honey, wax, and salt, their yearly exports may be about 400 l. and this comes pretty near the sum of their exports, which we estimate together at 18,100 l. Sterling *per annum*.

A vast balance lies against them, if we consider the variety and importance of the articles they fetch from other countries, for which they must pay ready cash. Here it may be necessary to withdraw some things from the heap, such as their cattle, sheep, and fowls, on which they get a profit; for the country does not produce them in a sufficient abundance to supply them, especially when we have a fleet of men of war stationed there.

Their imports are, corn, cattle, sheep, fowls tobacco, oil, rice, sugar, spices, hard-ware, and tools of all kinds; gold and silver lace; chocolate, or cacao to make it; tobacco, timber, plank, boards, mill-stones, tobacco-pipes, playing cards, turnery ware, seeds, soap, saddles; all manner of cabinet-makers work, iron spikes, nails, fine earthen-ware, glass, lamps, brassery, paper, and other stationary wares; copperas, galls, dye-stuffs, painters brushes, and colours; musical instruments, music, and strings; watches, wine, fruit, all manner of fine and printed linens, muslins, cambrics, and laces; bottles, corks, flurch, indigo, fans, trinkets, toys, ribbands, tape, needles, pins, silk, mohair, lanterns, cordage, tar, pitch, rosin, drugs, gloves, fire-arms, gunpowder, shot, and lead; hats, caps, velvet, cotton stuffs, woollen cloths, stockings, capes, medals, vestments, lustrés, pictures, images, agnus Dei's, books, pardons, bulls, relics, and indulgences.

The island is divided into what they style *terminos*, of which there were anciently five, now reduced to four, and resemble our counties. The termino of Ciudadella, at the north-western extremity of the island, is so styled from this place, which was once a city, and the capital of Minorca. It makes a venerable and majestic figure, even in its present state of decay, having in it a large Gothic cathedral, some other churches and convents, the governor's palace, and an exchange, which is no contemptible pile. There are in it 600 houses, which, before the seat of government and the courts of justice were removed to Mahon, were fully inhabited; and there are still more gentlemen's families here than in all the rest of the island. It hath a port commodious enough for the vessels employed in the trade of this country, which, though in the possession of a maritime power, is less than it formerly was. It is still, in the style of our officers, *the best quarters* (and there are none bad), in the country; and if there was a civil government, and the place made a free port, the best judges are of opinion it would very soon become a flourishing place again; and the fortifications, if it should be found

necessary, might then also be easily restored and improved. *Minorca.*

The termino of Fererias is the next, a narrow slip reaching crofs from sea to sea, and the country little cultivated; it is therefore united to Mercadall. In this last termino stands Mont-toro in the very centre of the isle, and the highest ground, some say the only mountain in it; on the summit of which there is a convent, where, even in the hottest months, the monks enjoy a cool air, and at all times a most delightful prospect. About six miles north from Mont-toro stands the castle that covers Port Fornelles, which is a very spacious harbour on the east side of the island. There are in it shoals and foul ground, which, to those who are unacquainted with them, render it difficult and dangerous; yet the packets bound from Mahon to Marfeilles frequently take shelter therein; and while the Spaniards were in possession of the isle, large ships and men of war frequented it. At a small distance from this lies another harbour called *Adaia*, which runs far into the land; but being reputed unsafe, and being so near Fornelles, is at present useless. The country about it is, however, said to be the pleasantest and wholesomest spot in the island, and almost the only one plentifully supplied with excellent spring-water, so that the gardens are well laid out, and the richest and finest fruits grow here in the highest perfection. Alaior is the next termino, in which there is nothing remarkable but the capital of the same name, well situated on an eminence, in a pleasant and tolerably cultivated country.

The termino of Mahon, at the south-east end of the island, is at present the most considerable of them all, containing about 60,000 English acres, and nearly one-half of the inhabitants in Minorca. The town of Mahon derives its name from the Carthaginian general Mago, who is universally allowed to be its founder. It stands on an eminence on the west side of the harbour, the ascent pretty steep. There are in it a large church, three convents, the governor's palace, and some other public edifices. It is large; but the streets are winding, narrow, and ill-paved. The fortrefs of St Philip stands near the entrance of the harbour, which it covers, is very spacious, of great strength, with subterranean works to protect the garrison from bombs, large magazines, and whatever else is necessary to render it a complete fortification, and hath a numerous and well-disposed artillery. Port Mahon is allowed to be the finest harbour in the Mediterranean, about 90 fathoms wide at its entrance, but within very large and safe, stretching a league or more into the land. Beneath the town of Mahon there is a very fine quay, one end of which is reserved for the ships of war, and furnished with all the accommodations necessary for careening and refitting them; the other serves for merchantmen. On the other side the harbour is Cape Mola, where it is generally agreed a fortrefs might be constructed which would be impregnable, as the castle of St Philip was esteemed before we took it, and bestowed so much money upon it, that, though some works were erected at Cape Mola, it was not judged proper to proceed in the fortifications there at a fresh expence; at least this is the only reason that hath been assigned.

MINOS, in fabulous history, king of Crete, was Rhadaman-

**Minotaur** the son of Jupiter and Europa. He is said to have built several cities in the island of Crete; to have given laws to the Cretans; and to have had a son, from whom sprung Minos II. king of Crete, Sarpedon, and Rhadamanthus, who distributed justice with such severity, that they were, according to the poets, constituted judges of hell, where the most difficult cases were referred to Minos, who was distinguished from the rest by his holding a sceptre of gold.

**MINOTAUR**, in antiquity, a fabulous monster much talked of by the poets, feigned to be half man and half bull.

The minotaur was brought forth by Pasiphæe, wife of Minos king of Crete. It was shut up in the labyrinth of that island, and at last killed by Theseus.

Servius gives the explanation of this fable: he says that a secretary of king Minos, named *Taurus*, "bull," having an intrigue with the queen (Pasiphæe) in the chamber of Dædalus, she was at length delivered of twins; one of whom resembled Minos, and the other *Taurus*. This occasioned the production to be reputed monstrous.

**MINOW**, a very small species of cyprinus, so well known that it needs no description.

**MINSTREL**, an ancient term for a singer and instrumental performer.

The word *minstrel* is derived from the French *menestrier*, and was not in use here before the Norman conquest. It is remarkable, that our old monkish historians do not use the word *citharædus*, *cantator*, or the like, to express a *minstrel* in Latin; but either *minus*, *histrion*, *joculator*, or some other word that implies *gesture*. Hence it should seem that the *minstrels* set off their singing by mimicry, or action; or, according to Dr Brown's hypothesis, united the powers of melody, poem, and dance.

The Saxons, as well as the ancient Danes, had been accustomed to hold men of this profession in the highest reverence. Their skill was considered as something divine, their persons were deemed sacred, their attendance was solicited by kings, and they were every-where loaded with honours and rewards. In short, poets and their art were held among them in that rude admiration which is ever shewn by an ignorant people to such as excel them in intellectual accomplishments. When the Saxons were converted to Christianity, in proportion as letters prevailed among them, this rude admiration began to abate, and poetry was no longer a peculiar profession. The poet and the *minstrel* became two persons. Poetry was cultivated by men of letters indiscriminately, and many of the most popular rhymes were composed amidst the leisure and retirement of monasteries. But the *minstrels* continued a distinct order of men, and got their livelihood by singing verses to the harp at the houses of the great. There they were still hospitably and respectfully received, and retained many of the honours shewn to their predecessors the Bards and Scalds. And indeed, though some of them only recited the compositions of others, many of them still composed songs themselves; and all of them could probably invent a few stanzas on occasion. There is no doubt but most of the old heroic ballads were produced by this order of men. For although some of

the larger metrical romances might come from the pen of the monks or others, yet the smaller narratives were probably composed by the *minstrels* who sung them. From the amazing variations which occur in different copies of these old pieces, it is evident they made no scruple to alter each other's productions, and the reciter added or omitted whole stanzas, according to his own fancy or convenience.

In the early ages, as is hinted above, this profession was held in great reverence among the Saxon tribes, as well as among their Danish brethren. This appears from two remarkable facts in history, which shew that the fame arts of music and song were equally admired among both nations, and that the privileges and honours conferred upon the professors of them were common to both; as it is well known their customs, manners, and even language, were not in those times very dissimilar.

When king Alfred the Great was desirous to learn the true situation of the Danish army, which had invaded his realm, he assumed the dress and character of a *minstrel*; and taking his harp, and only one attendant, (for in the earliest times it was not unusual for a *minstrel* to have a servant to carry his harp), he went with the utmost security into the Danish camp. And though he could not but be known to be a Saxon, the character he had assumed procured him a hospitable reception; he was admitted to entertain the king at table, and staid among them long enough to contrive that assault which afterwards destroyed them. This was in the year 878.

About 60 years after, a Danish king made use of the same disguise to explore the camp of king Athelstan. With his harp in his hand, and dressed like a *minstrel*, Anlaf king of the Danes went among the Saxon tents, and taking his stand near the king's pavilion, began to play, and was immediately admitted. There he entertained Athelstan and his lords with his singing and his music; and was at length dismissed with an honourable reward, though his songs must have discovered him to have been a Dane. Athelstan was saved from the consequences of this stratagem by a soldier, who had observed Anlaf bury the money which had been given him, from some scruple of honour, or motive of superstition. This occasioned a discovery.

From the uniform procedure of both these kings, it is plain that the same mode of entertainment prevailed among both people, and that the *minstrel* was a privileged character among both. Even as late as the reign of Edward II. the *minstrels* were easily admitted into the royal presence, as appears from a passage in Stow, which also shews the splendour of their appearance.

"In the year 1316, Edward the second did solemnize his feast of Pentecost at Westminster, in the great hall: where sitting royally at the table with his peers about him, there entered a woman adorned like a *minstrel*, sitting on a great horse trapped, as *minstrels* then used, who rode round about the tables, shewing pastime; and at length came up to the king's table, and laid before him a letter, and forthwith turning her horse, saluted every one, and departed."—The subject of this letter was a remonstrance to the king on the favours heaped by him on his minions, to

Mintrel.

the neglect of his knights and faithful servants

The messenger was sent in a minstrel's habit, as what would gain an easy admission; and was a woman concealed under that habit, probably to disarm the king's resentment: for we do not find that any of the real minstrels were of the female sex; and therefore conclude this was only an artful contrivance peculiar to that occasion.

In the 4th year of Richard II. John of Gaunt erected at Tetbury in Staffordshire a court of minstrels, with a full power to receive fine and service from the men of this profession within five neighbouring counties, to enact laws, and determine their controversies; and to apprehend and arrest such of them as should refuse to appear at the said court, annually held on the 16th of August. For this they had a charter, by which they were empowered to appoint a king of the minstrels, with four officers, to preside over them. These were every year elected with great ceremony; the whole form of which is described by Dr Plot: in whose time, however, they seem to have become mere musicians.

Even so late as the reign of king Henry VIII. the reciters of verses or moral speeches learnt by heart, intruded without ceremony into all companies; not only in taverns, but in the houses of the nobility themselves. This we learn from Erasmus, whose argument led him only to describe a species of these men who did not sing their compositions; but the others that did, enjoyed without doubt the same privileges.

We find that the minstrels continued down to the reign of Elizabeth; in whose time they had lost much of their dignity, and were sinking into contempt and neglect. Yet still they sustained a character far superior to any thing we can conceive at present of the singers of old ballads.

When queen Elizabeth was entertained at Killingworth castle by the earl of Leicester in 1575, among the many devices and pageants which were exhibited for her entertainment, one of the personages introduced was that of an ancient minstrel, whose appearance and dress are so minutely described by a writer there present, and gives us so distinct an idea of the character, that we shall quote the passage at large.

"A person very meet seemed he for the purpose, of a xlv. years old, apparelled partly as he would himself. His cap off: his head seemingly rounded tonterwise: fair-kembed, that, with a sponge daintly dipt in a little capon's grease, was finely smoothed, to make it shine like a mallard's wing. His beard smugly shaven: and yet his shirt after the new trink, with ruffs fair starched, sleeked and glittering like a pair of new shoes, marshalled in good order with a setting slick, and strut, 'that' every ruff stood up like a wafer. A side [i. e. long] gown of Kendale green, after the freshness of the year now, gathered at the neck with a narrow gorget, fastened afore with a white clasp and a keeper close up to the chin; but easily, for heat, to undo when he list. Seemingly begirt in a red caddis girdle: from that a pair of capped Sheffield knives hanging a' two sides. Out of his bosom drawn from a lapet of his napkin edged with a blue lace, and marked with a D for Damian; for he was but a bachelor yet.

"His gown had side [i. e. long] sleeves down to mid-

leg, slit from the shoulder to the hand, and lined with white cotton. His doublet-sleeves of black worsted: upon them a pair of points of tawny-chamlet laced along the writh with blue threaden pointes. A waist towards the hands of fustian-a-napes. A pair of red neather stocks. A pair of pumps on his feet, with a cross cut at his toes for corns; not new indeed, yet cleanly blackt with foot, and shining as a shoing horn.

"About his neck a red ribband suitable to his girdle. His harp in good grace dependent before him. His wreat tied to a green lace and hanging by: under the gorget of his gown a fair flaggon chain, (pewter for) silver, as a squire Minstrel of Middlesex, that travelled the country this summer season, unto fair and worshipful mens houses. From his chain hung a scutcheon, with metal and colour, resplendent upon his breast, of the ancient arms of Islington."

—This minstrel is described as belonging to that village. We suppose such as were retained by noble families, wore their arms hanging down by a silver chain as a kind of badge. From the expression of Squire Minstrel above, we may conclude there were other inferior orders, as Yeomen Minstrels, or the like.

This minstrel, the author tells us a little below, "after three lowly courtesies, cleared his voice with a hem . . . and wiped his lips with the hollow of his hand for 'siling his napkin; tempered a string or two with his wreat; and, after a little warbling on his harp for a prelude, came forth with a solemn song, warranted for story out of king Arthur's acts, &c."

Towards the end of the 16th century, this class of men had lost all credit, and were sunk so low in the public opinion, that in the 39th year of Elizabeth a statute was passed by which "minstrels, wandering abroad" were included among "rogues, vagabonds, and sturdy beggars," and were adjudged to be punished as such. This act seems to have put an end to the profession, for after this time they are no longer mentioned.

MINT, the place in which the king's money is coined. See COINAGE.

There were anciently mints in almost every county in England; but the only mint at present in the British dominions is that in the tower of London. The officers of the mint are, 1. The warden of the mint, who is the chief; he oversees the other officers, and receives the bullion. 2. The master-worker, who receives the bullion from the warden, causes it to be melted, delivers it to the moneyers, and, when it is coined, receives it again. 3. The comptroller, who is the overseer of all the inferior officers, and sees that all the money is made to the just assize. 4. The assay-master, who weighs the gold and silver, and sees that it is according to the standard. 5. The auditor, who takes the accounts. 6. The surveyor of the melting; who, after the assay-master has made trial of the bullion, sees that it is cast out, and not altered after it is delivered to the melter. 7. The engraver; who engraves the stamps and dyes for the coining of the money. 8. The clerk of the irons; who sees that the irons are clean and fit to work with. 9. The melter; who melts the bullion before it be coined. 10. The provost of the mint; who provides for and oversees

Minstrel,  
Mint.



overfees all the moneys. 11. The blanchers, who anneal and cleanse the money. 12. The moneys; some of whom forge the money, some shear it, some round and mill it, and some stamp and coin it. 13. The porters, who keep the gate of the mint.

**MINT-Marks.** It hath been usual, from old time, to oblige the masters and workers of the mint, in the indentures made with them, "to make a privy mark in all the money that they made, as well of gold as of silver, so that another time they might know, if need were, and write which moneys of gold and silver among other of the same moneys, were of their own making, and which not." And whereas, after every trial of the *pix* at Westminster, the masters and workers of the mint, having proved their moneys to be lawful and good, were immediately entitled to receive their *quietus* under the great seal, and to be discharged from all suits or actions concerning those moneys, it was then usual for the said masters and workers to change the privy mark before used for another, that so the moneys from which they were not yet discharged might be distinguished from those for which they had already received their *quietus*; which new mark they then continued to stamp upon all their moneys, until another trial of the *pix* gave them also their *quietus* concerning those.

The *pix* is a strong box with three locks, whose keys are respectively kept by the warden, master, and comptroller of the mint; and in which are deposited, sealed up in several parcels, certain pieces taken at random out of every *journey*, as it is called; that is, out of every 15 pounds weight of gold, or 60 pounds weight of silver, before the same is delivered to the proprietors. And this *pix* is, from time to time, by the king's command, opened at Westminster, in the presence of the lord-chancellor, the lords of the council, the lords-commissioners of the treasury, the justices of the several benches, and the barons of the exchequer; before whom a trial is made, by a jury of goldsmiths impanelled and sworn for that purpose, of the collective weights of certain parcels of the several pieces of gold and silver taken at random from those contained in the *pix*; after which those parcels being severally melted, assays are then made of the bullion of gold and silver so produced, by the melting certain small quantities of the same against equal weights taken from the respective trial-pieces of gold and silver that are deposited and kept in the exchequer for that use. This is called the *trial of the pix*; the report made by the jury upon that trial is called the *verdict of the pix* for that time; and the indented trial-pieces just above-mentioned, are certain plates of standard gold and standard silver, made with the greatest care, and delivered in upon oath, from time to time as there is occasion, by a jury of the most able and experienced goldsmiths, summoned by virtue of a warrant from the lords of the treasury to the wardens of the mystery of goldsmiths of the city of London for that purpose; and which plates being so delivered in, are divided each, at this time, into seven parts by indentures, one of which parts is kept in his majesty's court of exchequer at Westminster, another by the said company of goldsmiths, and two more by the officers of his majesty's mint in the tower; the remaining three being for the use of the mint, &c. in Scotland. The

*pix* has sometimes been tried every year, or even oftener, but sometimes not more than once in several years: and from hence is understood how it comes to pass, that, among the pieces that are dated as well as marked, three or more different dates are sometimes found upon pieces impressed with the same mark; and again, that different marks are found upon pieces bearing the same date. These marks are first observable upon the coins of king Edward III.; the words above quoted concerning those marks are from the indentures made with the lord Hastings, master and worker to king Edward IV.; and the marks themselves continued to be stamped very conspicuously upon the moneys, till the coinage by the mill and screw was introduced and settled after the Restoration, in the year 1662: since which time, the moneys being made with far greater regularity and exactness than before, these marks have either been totally laid aside, or such only have been used as are of a more secret nature, and only known to the officers and engravers concerned in the coinage: and indeed the constant practice that has ever since prevailed, of dating all the several pieces, has rendered all such marks of much less consequence than before.

**MINT, in botany.** See MENTHA.

**MINUET**, a very graceful kind of dance, consisting of a coupee, a high step, and a balance: it begins with a beat, and its motion is triple.

The invention of the minuets seems generally to be ascribed to the French, and particularly to the inhabitants of the province of Poitou. The word is said by Menage and Furetiere to be derived from the French *menu* or *menus*, "small, or little;" and in strictness signifies a small place. The melody of this dance consists of two strains, which, as being repeated, are called *reprises*, each having eight or more bars, but never an odd number. The measure is three crotchets in a bar, and is thus marked  $\frac{3}{8}$ , though it is commonly performed in the time  $\frac{1}{2}$ . Walther speaks of a minuet in Lully's opera of *Roland*, each strain of which contains ten bars, the sectional number being 5; which renders it very difficult to dance.

**MINUTE**, in geometry, the 60th part of a degree of a circle.

**MINUTE of Time**, the 60th part of an hour.

**MINUTE**, in architecture, usually denotes the 60th, sometimes the 30th, part of a module. See ARCHITECTURE.

**MINUTE** is also used for a short memoir, or sketch of a thing taken in writing.

**MINUTIUS FELIX.** See FELIX.

**MIQUELETS**, a name given to the Spaniards who inhabit the Pyrenean mountains on the frontiers of Arragon and Catalonia, and live by robbing.

**MIQUELON**, a small desert island to the south-west of Cape May in Newfoundland, ceded to the French by the peace of 1763, for drying and curing their fish. W. Long. 54. 30. N. Lat. 47. 22.

**MIRABILIS, MARVEL OF PERU**; a genus of the monogynia order, belonging to the pentandria class of plants.

The most remarkable species are,

1. The jalappa, or common marvel of Peru, hath a large, thick, fleshy root; an upright, thick, jointed stalk, dividing and branching numerously, widely,

29 A 2 and

Mirabilis.

and erectly, a yard or more high; garnished with oblong, broad, opposite leaves; and all the branches and shoots terminated by numerous flowers in clusters, of different colours in the varieties. Of this there are varieties with white flowers—with yellow flowers—with purple flowers—with red flowers—with white and yellow flowers—white and purple flowers—purple and yellow flowers—red and yellow flowers. Several other varieties often rise from seed; and it is remarkable that although several of the above colours and variegations are sometimes common to the same plant, yet it is rare that a plant of this species produces flowers of one of those colours alone; sometimes, however, the same plant will exhibit only white and purple flowers separate, and sometimes both colours in the same flowers, intermixed with the plain ones: the same is also observable in the red and yellow; others have plain flowers of several different colours, and sometimes variegated flowers also on the same plants. The root of this species was supposed to be the true official jalap, but which is since discovered to be the root of a species of *convolvulus*.

2. The longiflora, or long-flowered mirabilis, hath a large, thick, fleshy root; a thick stalk, dividing low into many declinated spreading branches, extending two or three feet every way; large, heart-formed, hairy, viscous leaves, in opposite pairs; and all the branches and shoots terminated by white flowers in clusters, having very long tubes, nodding downward.

3. The dichotoma, dichotomous, or forked mirabilis; hath a thick fleshy root; an upright, thick, swollen, jointed stem, branching forkedly two or three feet high; oblong opposite leaves; and smallish red flowers at the axillas, singly and close-fitting.

All these plants flower in July, continuing in plentiful succession until October, very conspicuous and elegant. They have the singularity of being shut all day, and expanding towards the evening when the sun declines; hence the inhabitants of the Indies, where they grow naturally, called them *four o'clock flowers*: their time of opening here, however, depends on the weather; for if cloudy, or that the sun is not very vehement, they often open great part of the day.

They are naturally perennial in root, which, however, if not preferred here in winter, prove but of one year's duration; but if sheltered from frost and wet during the winter season, they will remain alive, and shoot out strongly again in spring: in this country, however, the plants are commonly considered as annuals; because they rise from seed in the spring, and the same year produce flowers and perfect seed; and if left to nature in the open air, totally perish in winter, at the first attack of frost or excessive wet; but, as aforesaid, if in autumn, when the stalks begin to assume a state of decay, the roots are taken up, and preserved in sand in a dry room all winter, and planted again in spring, they shoot out afresh stronger than at first, and sometimes obtain four or five feet stature, with very spreading heads; or if plants growing in pots, having the stems cut down in autumn, and the pots placed in a green-house, or garden-frames under glasses, the roots may also be preserved sound, and will shoot out again in spring as above.

The roots generally become large, tuberous, and fleshy, covered with a dark rind.

Miracle.

All the species are of a tender nature, scarcely able to endure the open air here fully day and night, until May or June; that is, they being raised from seed in spring, chiefly in hot-beds under glasses, continued and forwarded there until the beginning of June, then fully exposed in the borders or pots, they become large branchy plants in July and August, and continue flowering until October or November, till prevented by the cold.

They are all elegant furniture for the principal compartments of the pleasure-ground, they being both very ornamental in their large branchy growth, closely garnished with leaves; and, by flowering so numerously, seem as if entirely covered with flowers, in constant plentiful succession from July till the beginning of winter, as aforesaid.

The roots of all these plants is a strong purgative, and given in a double quantity operate equal to the true jalap.

The propagation of all the species is by seed in the spring, either in a warm border, or in a hot-bed; but the latter will forward the plants to considerably the earliest and greatest degree of perfection.

MIRACLE, is defined by Dr Samuel Clarke, to be a work effected in a manner different from the common and regular method of providence, by the interposition either of God himself, or some intelligent agent superior to man.

It has been much controverted, whether true miracles can be worked by any less power than the immediate power of God; and whether to complete the evidence of a miracle, the nature of the doctrine pretended to be proved by it is necessary to be taken into the consideration. The above learned author undertakes to set this matter in a clear light, as follows.

In respect to the power of God, and the nature of the things themselves, all things that are possible at all, are equally easy to be done: it is at least as great an act of power to cause the sun to move at all, as to cause it at any time to stand still; yet this latter we call a *miracle*, the former not.

What degrees of power God may reasonably be supposed to have communicated to created beings or subordinate intelligences, is impossible for us to determine: therefore a miracle is not rightly defined to be such an effect as could not have been produced by any less power than the divine omnipotence. There is no instance of any miracle in scripture, which to an ordinary spectator would necessarily imply the immediate operation of original, absolute, and undervived power.

All things that are done in the world, are done either immediately by God himself, or by created intelligent beings, matter not being at all capable of any laws or powers whatsoever; so that all those things which we say are the effects of the natural powers of matter and laws of motion, are properly the effects of God acting upon matter continually and every moment, either immediately by himself, or mediately by some created intelligent beings. Consequently it is no more against the course of nature for an angel to keep a man from sinking in the water, than for a man to hold a stone from falling in the air, by overpowering the law of gravitation; and yet the one is a miracle, the other not so.

The only possible ways by which a spectator may certainly

**Miracle** certainly and infallibly distinguish miracles be the works either immediately of God himself, or of some good angel employed by him; or whether, on the contrary, they are the works of evil spirits, are these: If the doctrine attested by miracles, be in itself impious, or manifestly tending to promote vice; then, without all question, the miracles, how great soever they may appear to us, are neither worked by God himself, nor by his commission. If the doctrine itself be indifferent, and at the same time there be worked other miracles more and greater than the former, then that doctrine which is attested by the superior power must necessarily be believed to be divine: this was the case of Moses and the Egyptian magicians. If, in the last place, the doctrine attested by miracles tends to promote the honour of God, and the practice of righteousness among men; and yet nevertheless be not in itself demonstrable, nor could without a revelation be discovered to be actually true, and there is no pretence of more and greater miracles to contradict it, which is the case of the doctrine and miracles of Christ; then the miracles are unquestionably divine, and the doctrine must, without all controversy, be acknowledged as an immediate and infallible revelation from God.

The Lord Bacon observes, that a miracle was never wrought by God to convert an atheist, because the light of nature might have led him to confess a God: but miracles, says he, are designed to convert idolaters and the superstitious, who have acknowledged a deity, but erred in the manner of adoring him; because no light of nature extends so far as fully to declare the will and true worship of God.

Acosta inquiring into the cause why miracles are not wrought by the present missionaries for the conversion of heathen nations, as they were by the Christians of the primitive ages, gives this as one reason: That the Christians at first were ignorant men, and the Gentiles learned; but now, on the contrary, all the learning in the world is employed in the defence of the gospel, and there is nothing but ignorance to oppose it; and there can be no need of farther miracles in so good a cause, when it is in the hands of such able advocates against such weak adversaries. See the article **ABRIDGMENT**.

**MIRANDA-DE-EBRO**, a town of Spain in Old Castile, with a strong castle; seated in a country that produces excellent wine. The town is divided into two parts by the river, over which there is a handsome bridge. W. Long. 3. 10. N. Lat. 42. 52.

**MIRANDE**, a town of Gascony in France, capital of the county of Astarac; seated on a mountain near the river Bausse. E. Long. 0. 21. N. Lat. 42. 53.

**MIRANDO-DE-DOURO**, or **Douro**, a strong town of Portugal, and capital of the province of Tral-os-Montes, with a bishop's see. It is well fortified, and seated on a rock near the confluence of the rivers Douro and Frefna. W. Long. 5. 40. N. Lat. 41. 30.

**MIRANDOLA**, a town of Italy, and capital of a duchy of the same name, situate between the duchies of Mantua and Modena. It is a pretty large place, well fortified, and has also a strong citadel and fort. It has been several times taken and retaken; the last time by the king of Sardinia in 1742. E. Long. 11. 5.

N. Lat. 44. 52.

**MIRANDULA**. See **PICUS**.

**MIRIAM**, sister of Aaron and Moses, makes two or three remarkable appearances in scripture. It was owing to her that her mother was employed by Pharaoh's daughter as nurse to Moses. She put herself at the head of the women of Israel after their passage through the Red-Sea, in order to sing the song which the men had sung before. She joined with her brother Aaron in murmuring against Moses, and was severely chastised for that action; for she became leprous, and continued separate from the rest without the camp for seven days. She died before her brothers, though in the same year with them, and was buried at the public expence.

**MIRROR**, a name for a looking-glass, or any polished body, whose use is to form the images of distant objects by reflexion of the rays of light. See **REFLEXION**.

Mirrors are either plain, convex, or concave. The first reflect the rays of light in a direction exactly similar to that in which they fall upon them, and therefore represent bodies of their natural magnitude. The convex ones make the rays diverge much more than before reflexion, and therefore greatly diminish the images of those objects which they shew: while the concave ones, by collecting the rays into a focus, not only magnify the objects they shew, but will burn very fiercely when exposed to the rays of the sun; and hence they are commonly known by the name of *burning mirrors*. See **BURNING-MIRRORS**.

In ancient times the mirrors were made of some kind of metal; and from a passage in the Mosaic writings we learn that the mirrors used by the Jewish women were made of brass. The Jews certainly had been taught to use that kind of mirrors by the Egyptians; from whence it is probable, that brazen mirrors were the first kind used in the world. Any kind of metal indeed, when well polished, will reflect very powerfully; but of all others silver reflects the most, though it hath been in all countries too expensive a material for common use. Gold also is very powerful; and metals, or even wood, gilded and polished, will act very powerfully as burning mirrors. Even polished ivory, or straw nicely plaited together, will form mirrors capable of burning, if on a large scale.

Since the invention of glass, and the application of quicksilver to it, became generally known, it hath been universally employed for those plain mirrors used as ornaments to houses; but in making reflecting telescopes, they have been found much inferior to metallic ones. It doth not appear that the same superiority belongs to the metalline burning mirrors, considered merely as burning-glasses; since the mirror with which Mr Maquer melted platina, though only 22 inches diameter, and which was made of quicksilvered glass, produced much greater effects than M. Vilette's metalline speculum, which considerably exceeded it in size. It is very probable, however, that this mirror of M. Vilette's was by no means so well polished as it ought to have been; as the art of preparing the metal for taking the finest polish hath, but lately been discovered and published in the Philosophical Transactions by Mr Mudge. See **GLASS-GRINDING**.

Mire-crow *Grinding*, and the *Mechanical Part of Optics*.

Misc.

MIRE-CROW, SEA-CROW, or *Pewit*. See *LA-RUS*.

MISADVENTURE, in common language, signifies any unlucky accident which takes place without being foreseen.

MISADVENTURE, in law, has an especial signification for the killing a man partly by negligence, and partly by chance. See *HOMICIDE*.

MISCHNAH, or *MISNAH*, the code or collection of the civil law of the Jews. The Jews pretend, that when God gave the written law to Moses, he gave him also another which was not written; and which was preserved by tradition among the doctors of the synagogue, till Rabbi Judah, surnamed the *Holy*, seeing the danger they were in, through their dispersion, of departing from the traditions of their fathers, judged it proper to reduce them to writing. The *misnah* is divided in six parts: the first relates to the distinction of seeds in a field, to trees, fruits, tythes, &c.; the second regulates the manner of observing festivals; the third treats of women, and matrimonial cases; the fourth, of losses in trade, &c.; the fifth is on obligations, sacrifices, &c.; and the sixth treats of the several sorts of purification.

MISDEMEANOUR, in law, signifies a crime. Every crime is a misdemeanour; yet the law has made a distinction between crimes of an higher and a lower nature; the latter being denominated *misdemeanours*, the former *felonies*, &c. For the understanding of which distinction, we shall give the following definition from Blackstone's Commentaries, vol. iv. 5.

"A crime, or misdemeanour, is an act committed or omitted, in violation of a public law, either forbidding or commanding it. This general definition comprehends both *crimes* and *misdemeanours*; which, properly speaking, are mere synonymous terms; tho' in common usage, the word *crime* is made to denote such offences as are of a deeper and more atrocious dye; while smaller faults, and omissions of less consequence, are comprised under the gentler name of *misdemeanour* only.

MISE, in law-books, is used in various senses: thus it sometimes signifies costs or expences, in which sense it is commonly used in entering of judgments in actions personal. It is also used for the issue to be tried on the grand assize; in which case, joining of the mise upon the mere right, is putting in issue between the tenant and demandant, who has the best or clearest right.

MISE also signifies a tax or tallage, &c. An honorary gift, or customary present from the people of Wales to every new king or prince of Wales, anciently given in cattle, wine, and corn, but now in money, being 5000*l.* or more, is denominated a *mise*: so was the usual tribute or fine of 3000 merks paid by the inhabitants of the county palatine of Chester, at the change of every owner of the said earldoms, for enjoying their liberties. And at Chester they have a *mise-book*, wherein every town and village in the county is rated what to pay towards the *mise*. The 27 Hen. VIII. c. 26. ordains that lords shall have all such *misses* and profits of their lands as they had in times past, &c.

MISE, is sometimes also corruptly used for *measure*, in law French *mesur*, "a measure;" as a *mise place*, in some manors, is such a message or tenement as answers the lord a heriot at the death of its owner. 2. *Infl.* 528.

MISERICORDIA, in law, is an arbitrary fine imposed on any person for an offence: this is called *misericordia*, because the amercement ought to be but small, and less than that required by magna charta. If a person be outrageously amerced, in a court that is not of record, the writ called *moderata misericordia* lies for moderating the amercement according to the nature of the fault.

MISFORTUNE. An unlucky accident.

MISFORTUNE, or chance, in law, a deficiency of the will; or committing of an unlawful act by misfortune or chance, and not by design. In such case, the will observes a total neutrality, and does not co-operate with the deed; which therefore wants one main ingredient of a crime. See *CRIME*.

Of this, when it affects the life of another, we have spoken under the article *HOMICIDE*; and in this place have only occasion to observe, that if any accidental mischief happens to follow from the performance of a lawful act, the party stands excused from all guilt: but if a man be doing any thing unlawful, and a consequence ensues which he did not foresee or intend, as the death of a man or the like, his want of foresight shall be no excuse; for, being guilty of one offence, in doing antecedently what is in itself unlawful, he is criminally guilty of whatever consequence may follow the first misbehaviour.

MISFEASANCE, in law-books, signifies a trespass.

MISLETOE, in botany. See *VISCUM*.

MISNOMER, in law, a misnaming or mistaking a person's name. The Christian name of a person should always be perfect; but the law is not so strict in regard to surnames, a small mistake in which will be dispensed with to make good a contract, and support the act of the party. See *PLEA to Indictment*.

MISO. See *DOLICHOS*.

MISPRISIONS, (a term derived from the old French, *mespris*, a neglect or contempt), are, in the acceptance of our law, generally understood to be all such high offences as are under the degree of capital, but nearly bordering thereon: and it is said, that a misprison is contained in every treason and felony whatsoever; and that, if the king so please, the offender may be proceeded against for the misprison only. And upon the same principle, while the jurisdiction of the star-chamber subsisted, it was held that the king might remit a prosecution for treason, and cause the delinquent to be censured in that court, merely for a high misdemeanour: as happened in the case of Roger earl of Rutland, in 43 Eliz. who was concerned in the earl of Essex's rebellion. Misprisions are generally divided into two sorts; negative, which consist in the concealment of something which ought to be revealed; and positive, which consist in the commission of something which ought not to be done.

1. Of the first, or negative kind, is what is called *misprison of treason*; consisting in the bare knowledge and concealment of treason, without any degree of assent thereto: for any assent makes the party a principal

Misericordia

Misprison

**Misprifions** pal traitor; as indeed the concealment, which was conftrud aiding and abetting, did at the common law; in like manner as the knowledge of a plot againft the ftate, and not revealing it, was a capital crime at Florence, and other ftates of Italy. But it is now enacted by the ftatute 1 & 2 Ph. & Mar. c. 10. that a bare concealment of treason fhall be only held a mifprifion. This concealment becomes criminal, if the party apprifed of the treason does not, as foon as conveniently may be, reveal it to fome judge of affize or juftice of the peace. But if there be any probable circumftances of affent, as if one goes to a treasonable meeting, knowing beforehand that a confpiracy is intended againft the king; or, being in fuch company once by accident, and having heard fuch treasonable confpiracy, meets the fame company again, and hears more of it, but conceals it; this is an implied affent in law, and makes the concealer guilty of aétual high-treason.

Mifprifion of felony is alfo the concealment of a felony which a man knows, but never affented to; for, if he affented, this makes him either principal or acceffory. And the punishment of this, in a public officer, by the ftatute Weftm. 1. 3 Edw. I. c. 9. is imprifonment for a year and a day; in a common perfon, imprifonment for a lefs difcretionary time; and, in both, fine and ransom at the king's pleafure: which pleafure of the king muft be obferved, once for all, not to fignify any extrajudicial will of the fovereign, but fuch as is declared by his representatives, the judges in his courts of juftice; *voluntas regis in curia, non in camera*.

2. Mifprifions, which are merely pofitive, are generally denominated *contempt* or *high mifdemour*; of which the principal is the *mal-adminiftration* of fuch high officers as are in public truft and employment. This is ufually punifhed by the method of parliamentary impeachment: wherein fuch penalties, fhort of death, are inflifted, as to the wifdom of the houfe of peers fhall feem proper; confifting ufually of banifhment, imprifonment, fines, or perpetual difability. Hither alfo may be referred the offence of *embezzling the public money*, called among the Romans *peculatus*; which the Julian law punifhed with death in a magiftrate, and with deportation, or banifhment, in a private perfon. With us it is not a capital crime, but fubjects the committer of it to a difcretionary fine and imprifonment.—Other mifprifions are, in general, fuch contempts of the executive magiftrate as demonftrate themfelves by fome arrogant and undutiful behaviour towards the king and government; for a detail of which, vide Blackftone's Comment. iv. 22.

**MISSAL**, the Romifh mafs-book, containing the feveral maffes to be faid on particular days. It is derived from the Latin word *miſſa*, which, in the ancient Chriftian church, fignified every part of divine fervice.

**MISSEL-BIRD**, a fpecies of **TURDUS**.

**MISSIONARIES**, fuch eccleſiaſtics as are fent by any Chriftian church into Pagan or Infidel countries, to convert the natives, and eſtabliſh the Chriftian religion among them.

There are in France, and other Popifh countries, feveral congregations of miffionaries, whofe principal end is to be employed on miffions, and to infpire into the

young clerks that ſpirit of piety and devotion which is neceffary for the worthy difcharge of their miffionary. Such are the congregations of the priefts of the miffion, the Eudifts, the miffionaries of Lyons, and fome others. The moſt remarkable of theſe congregations is that of the priefts of the miffion, which confiſts of ſecular clergy; who neverthelefs make four fimple vows, of poverty, chaſtity, obedience, and perfeverance. Their habit is diſtinguiſhed from that of other eccleſiaſtics only by a linen-collar four fingers broad, and by their wearing a little tuft of beard.

**MISSISSIPPI**, alfo called the *river of St Louis*, is one of the largeſt in the world. Its fource is unknown: for it has not been navigated higher than 300 miles below the fall or cataract of St Anthony; and there it is 30 fathoms deep, though at the diftance of 2400 miles from its mouth. It difcharges itfelf into the ſea by three mouths; and, like the Nile, has periodical inundations, by the melting of ſnow in the north, fo that in May it overflows the country on each ſide, from 60 to 90 miles, and the inundation continues till near the end of July. In the loweſt parts of the country there are moraffes, lakes, and canals, along the banks, which are generally covered with trees, and in fome places the courſe of the river is confined between high precipices. Its inundations always leave a great quantity of mud upon the land, and ſometimes carry down trees to the river's mouth, where they form new iflands, and render the entrance difficult.

**MISSON** (Francis Maximilian), whofe pleadings before the parliament of Paris in favour of the reformers bear genuine marks of eloquence and ability, retired into England after the revocation of the edict of Nantz, and became a strenuous affector of the Proteſtant religion. In the years 1687 and 1688, he travelled to Italy as governor to an Engliſh nobleman: in confequence of which he publiſhed at the Hague, "A new voyage to Italy," 3 vols 12mo; which has been tranſlated into Engliſh with many additions. He publiſhed alfo the "Sacred Theatre at Cevennes, or an account of Prophecies and Miracles performed in that part of Languedoc," London 1707. "Obſervations and remarks of a traveller," 12mo, Hague. He died at London in 1721.

**MISTAKE**, any wrong action committed, not through an evil deſign, but through an error of judgment.

**MISTAKE**, in law. See **IGNORANCE**.

**MISUSER**, in law, is an abufe of any liberty or benefit; as "He ſhall make fine for his **MISUSER**." Old. Nat. Br. 249. By *miſuſer* a charter of a corporation may be forfeited; fo alfo an office, &c.

**MISY**, in natural hiſtory, a ſpecies of the chalcantia, a foſſil very common in the Turkiſh dominions, and ſometimes found in the mines of Cremitz in Hungary. It is a conſiderably firm ſubſtance, of an irrefracture, not compact; much reſembling ſome of our more gaudy marcaſites, but wanting in their hardneſs and weight. It is of no determinate ſhape or ſize; but is often found in ſmall detached maſſes, which are uſually broad, flat, and very rugged at the edges. As to its medical virtues, they are no other than thoſe of the green vitriol.

**MITE**, a ſmall coin formerly current, and equal to about one-third part of a farthing.

**MITE**,

Mitella  
Mitimus.

**MITE**, in zoology. See **ACARUS**.  
**MITELLA**, **BASTARD AMERICAN SANICLE**; a genus of the digynia order, belonging to the decandria class of plants. There are two species, both natives of North America, rising with annual herbaceous stalks from five or six to eight or nine inches in height, and producing spikes of small whitish flowers, whose petals are fringed on their edges. They are easily propagated by parting their roots; and should be planted in a shady situation, and in a soft loamy soil. The fruit of one of the species is the achiotte, or arnotto.

**MITHRIDATE**, in pharmacy, an antidote, or composition, in form of an electuary, supposed to serve either as a remedy or a preservative against poisons. See **PHARMACY**, n° 892.—894. It takes its name from the inventor, Mithridates king of Pontus; who is said to have so fortified his body against poisons with antidotes and preservatives, that when he had a mind to dispatch himself, he could not find any poison that would take effect. The receipt of it was found in his cabinet, written with his own hand, and was carried to Rome by Pompey. It was translated into verse by Damocrates, a famous physician; and was afterwards translated by Galen, from whom we have it: though there is room to imagine it has undergone considerable alterations since the time of its royal prescriber.

**MITHRIDATES**, king of Pontus, a renowned general, and at first successful against the Romans: but being finally conquered by Pompey, and his son Pharnaces raised to the throne, who treated him with unnatural barbarity, he took poison; but this proving ineffectual, owing to a salutary medicine which he had almost constantly employed, he was slain at his own request by one of his attendants, 63 B. C. aged 72. He was a prince of extraordinary courage, capable of forming and executing the greatest designs. He had travelled a great deal, was learned, fond of men of letters, and spoke many languages. He composed a treatise *De Arcanis Morborum*; which Pompey caused to be carried to Rome, and which his freedman Læneus translated into Latin. It was he who composed that counter-poison which from his name is still called *mithridate*; but his sanguinary temper darkened the lustre of his most amiable perfections. See **PONTUS**.

**MITRE**, a sacerdotal ornament worn on the head by bishops and certain abbots on solemn occasions; being a sort of cap, pointed and cleft at top. The high-priest among the Jews wore a mitre or bonnet on his head. The inferior priests of the same nation had likewise their mitres; but in what respect they differed from that of the high priest, is uncertain. Some contend that the ancient bishops wore mitres; but this is by no means certain.

**MITTAU**, the capital of the duchy of Courland. It is strongly fortified; but was taken by the Swedes in 1701, and by the Muscovites in 1706. E. Long. 23. 51. N. Lat. 56. 44.

**MITTIMUS**, as generally used, hath two significations. 1. It signifies a writ for removing or transferring of records from one court to another. 2. It signifies a precept, or command in writing, under the hand and seal of a justice of the peace, directed to the gaoler or keeper of some prison, for the receiving and

safe keeping of an offender charged with any crime, until he be delivered by due course of law.

**MITYLENE**, (anc. geog.), a celebrated, powerful, and affluent city of Lesbos; nor was it less famous for the study of philosophy and eloquence. It suffered much in the Peloponnesian war from the Athenians; and in the Mithridatic war from the Romans, being taken and destroyed; but it soon rose again, having recovered its ancient liberty, by the favour of Pompey, (Velleius, Plutarch). It remained a free city and in power 1500 years. The country of Pittacus, one of the seven wise men of Greece; of Alcæus, and of Sappho. *Mytilleneis*, or *Mytillenses*, the people; who at stated times celebrated poetical contests, (Plutarch). Cicero calls it a city ennobled by nature and situation, especially by the beauty of its edifices, and by its plains, which are pleasaunt and fertile. It is sometimes by the poets joined with Rhodes, (Horace, Martial). *Mityleneus*, the epithet, (Luca). It now gives name to the whole island, and this as early as the days of Eustathius; and is itself called *Castro*.

**MIXT**, or **MIXT BODY**, in chemistry, that which is compounded of different elements or principles.

**MIXTURE**, a compound, or assemblage of several different bodies in the same mass. Simple mixture, consists only in the simple apposition of parts of different bodies to each other. Thus, when powders of different kinds are rubbed together, the mixture is only simple, and each of the powders retains its particular characters. In like manner, when oil and water are mixed together, though the parts of both are confounded, so that the liquor may appear to be homogeneous, we cannot say that there is any more than a simple apposition of the parts, as the oil and water may very easily be again separated from each other. But the case is very different when bodies are *chemically* mixed; for then one or both bodies assume new properties, and can by no means be discovered in their proper form without a particular chemical process adapted to this purpose. Hence chemical mixture is attended with many phenomena which are never observed in simple mixtures; such as heat, effervescence, &c. To chemical mixture belongs the union of acids and alkalies, the amalgamation of metals, solution of gums, &c. and upon it depend many of the principal operations of chemistry. See that article *passim*.

**MIZEN**, in the sea-language, is a particular mast or sail. The mizen-mast stands in the sternmost part of the ship. In some great ships there are two of these; when that next the main-mast is called the *main-mizen*, and that next the poop the *bonaventure mizen*.

**MIZRAIM**, or **MISRAIM**, the dual name of Egypt, used in scripture to denote the Higher and Lower Egypt, which see. It sometimes occurs singular, *Mazor*: 2 Kings xix. Isaiah xix. Micah vii.

**MNIUM**, **MARSHMOSS**; a genus of the order of musci, belonging to the cryptogamia class of plants. There are 18 species, of which seven are natives of Britain; but none have any remarkable property except the two following. 1. The fontanum is an elegant moss, frequent in bogs, and on the borders of old springs. It is from two to four inches high: the stalks are simple at the base, and covered with a rusty down; but higher up are red, and divided into several

Mitylene  
Mnium.

Moab  
||  
Mocha.

veral round, single, taper branches, which proceed nearly from the same point. The leaves are not more than  $\frac{1}{2}$  of an inch long, lanceolate and acute, of a whitish green colour, and so thinly set, that the red stalk appears between them. This moss, as it may be seen at a considerable distance, is a good mark to lead to the discovery of clear and cold springs. Linnæus informs us, that the Laplanders are well acquainted with this sign. Mr Withering informs us, that wherever this moss grows, a spring of fresh water may be found without much digging. 2. The hygrometricum grows in woods, heaths, garden-walks, walls, old trees, decayed wood, and where coals or cinders have been laid. It is stemless, hath tips inversely egg-shaped, nodding, and bright yellow. If the fruit-stalk is moistened at the base with a little water or steam, the head makes three or four revolutions: if the head is moistened, it turns back again.

MOAB, (anc. geog.), a country of Arabia Petraea; so called from Moab the son of Lot, to whose posterity this country was allotted by divine appointment, Deut. xi. 9. It was anciently occupied by the Emim, a race of giants extirpated by the Moabites, *ibid.* Moab anciently lay to the south of Ammon, before Sihon the Amorite stripped both nations of a part of their territory, afterwards occupied by the Israelites, Numb. xxi.; and then Moab was bounded by the river Arnon to the north, the Lacus Asphaltites to the west, the brook Zared to the south, and the mountains Abarim to the east.

MOAT, or DITCH, in fortification, a deep trench dug round the rampart of a fortified place, to prevent surprises.

The brink of the moat, next the rampart, is called the *scarpe*; and the opposite one, the *counter-scarpe*.

A dry moat round a large place, with a strong garrison, is preferable to one full of water; because the passage may be disputed inch by inch, and the besiegers, when lodged in it, are continually exposed to the bombs, grenades, and other fire-works, which are thrown incessantly from the rampart into their works. In the middle of dry moats, there is sometimes another small one, called *cunette*; which is generally dug low deep, till they find water to fill it.

The deepest and broadest moats are accounted the best; but a deep one is preferable to a broad one: the ordinary breadth is about 20 fathoms, and the depth about 16.

To drain a moat that is full of water, they dig a trench deeper than the level of the water, to let it run off; and then throw hurdles upon the mud and slime, covering them with earth or bundles of rushes, to make a sure and firm passage.

MOCHO, Moco, or *Mokha*; by some supposed to be the Mufa or Muza of Ptolemy, is a port and town on the Red-Sea, of considerable trade; contains about 10,000 inhabitants, Jews, Armenians, and Mohammedans, is surrounded with walls after the ancient manner, and has four gates and four towers, the last mounted with cannon, but no ditch. It gives name to a kingdom extending along the most southern coast of Arabia; of which that part which lies next the sea is a dry barren desert, in some places 10 or 12 leagues

over; but bounded by mountains, which being well watered, enjoy an almost perpetual spring; and besides coffee, the peculiar produce of this country, yields corn, grapes, myrrh, frankincense, cassia, balm, gums of several sorts, mangos, dates, pomegranates, &c. The weather here is hot and sultry in summer, especially when the south wind blows, that it would be unupportable, if it was not mitigated by the cool breezes that generally blow from the mountains on the north, or the Red and Arabia Seas on the west and east. The heat in winter is equal to that of our warmest summers; and it is very seldom that either clouds or rain are seen. The city of Mocha is now the emporium for the trade of all India to the Red-Sea. The trade was removed hither from Aden, in consequence of the prophecy of a sheik, much revered by the people, who foretold, that it would soon become a place of extensive commerce, notwithstanding its disadvantageous situation. It stands close to the sea, in a large, dry, and sandy plain, that affords no good water within 20 miles of the city; what they drink comes from Mofa, and costs as dear as small-beer in England. The water near the town, as it is thought, produces a worm, which the naturalists call the *dracunculus*, which is about two feet and a half long, very slender, and breeds in the fleshy parts of the body: in extracting it great care must be used, the consequence being dangerous if any part of it remains in the body. The buildings here are lofty, and tolerably regular, having a pleasant aspect from Mecca. The steeples of several mosques are very high, presenting themselves to view at a great distance. Their markets are well stored with beef, mutton, lamb, kid, camels, and antelopes flesh, common fowls, Guinea hens, partridges, and pigeons. The sea affords plenty of fish, but not savoury; which some think proceeds from the extreme saltness of the water, and the nature of their aliment. The markets are also stocked with fruit, such as grapes, peaches, apricots, quinces, and nectarines; although neither flurub nor tree is to be seen near the town, except a few date-trees. Frequently no rain falls here in two or three years, and seldom more than a shower or two in a year; but in the mountains, at the distance of about 20 miles from Mokka, the earth is watered with a gentle shower every morning, which makes the vallies fertile in corn, and the fruits natural to the climate. The Arab inhabitants, though remarkably grave and superstitious, are said to be extremely covetous and hypocritical; robbing, thieving, and committing piracy, without the least scruple or remorse. The English and Dutch companies have handsome houses here, and carry on a great trade in coffee, olibanum, myrrh, aloes, liquid storax, white and yellow arsenic, gum-arabic, mummy, balm of Gilead, and other drugs. One inconvenience, however, they sustain from the violence and exactions of the Arabian princes; but the king's customs are easy, being fixed at *three per cent.* to Europeans. Of the coins at Mocha, the most current is the camasse, which rises and falls in value at the banker's discretion: they are from 50 to 80 for a current dollar, which is but an imaginary species, being always reckoned one and a half *per cent.* lower than Spanish dollars. As to their weights, they are almost

Mochis.

Mocking  
Mode.

infinite, according to the nature of the thing to be weighed: they have the banian weight; the magnet; the ambergrife; the agala; the gold and silver weights, &c.

MOCKING-BIRD, in ornithology. See TURDUS.

MOCOCO. See LEMUR.

MODE, in metaphysics, denotes the manner of a thing's existence. See METAPHYSICS, n° 50. 51. 55.—86.

MODE, in music; a regular disposition of the air and accompaniments relative to certain principal sounds upon which a piece of music is formed, and which are called the *essential sounds of the mode*.

There is this difference between the mode and the tone, that the latter only determines the principal found, and indicates the place which is most proper to be occupied by that system which ought to constitute the basis of the air; whereas the former regulates the thirds, and modifies the whole scale agreeably to its fundamental sounds.

Our *modes* are not, like those of the ancients, characterized by any sentiment which they tend to excite, but result from our system of harmony alone. The sounds essential to the mode are in number three, and form together one perfect chord. 1. The tonic or key, which is the fundamental note both of the tone and of the mode. (See TONE and TONIC). 2. The dominant, which is a fifth from the tonic. (See DOMINANT). 3. The mediant, which properly constitutes the *mode*, and which is a third from the same tonic. As this third may be of two kinds, there are of consequence two different modes. When the mediant forms a greater third with the tonic, the mode is major; when the third is lesser, it is minor.

The major mode is immediately generated by the resonance of sounding bodies, which exhibit the third major of the fundamental found: but the minor mode is not the product of nature; it is only found by analogy and invention. This is equally true upon the system of Sig. Tartini as upon that of M. Rameau.

This last author, in his various and successive publications, has explained the origin of this minor mode in different ways, of which his interpreter M. D'Alembert was satisfied with none. It is for this reason that he has founded this origin on a different principle which cannot be better explained than in the words of that eminent geometrician. See MUSIC, Art. 28, 29, 30 and 31.

When the mode is once determined, every note in the scale assumes a name expressive of its relation to the fundamental found, and peculiar to the place which it occupies in that particular mode. We subjoin the names of all the notes significant of their relative values and places in each particular *mode*, taking the octave of *ut* as an example of the major *mode*, and of *la* as an example of the minor.

Major, *ut re mi fa sol la si ut*,  
Minor, *la si ut re mi fa sol la*.

Octave.  
Seventh note.  
Sixth note,  
or  
Sub-dominant.  
Dominant.  
Fourth note,  
or  
Sub-dominant.  
Mediant.  
Second note.  
Tonic.

Mode.

It is necessary to remark, that when the seventh note is only a semitone distant from the highest in the octave, that is to say, when it forms a third major with the dominant, as *fi* natural in the major *mode*, or *sol* sharp in the minor; that seventh found is then called a *sensible note*, because it discovers the tonic and renders the tone appreciable.

Nor does each gradation only assume that name which is suitable to it; but the nature of each interval is determined according to its relation to the *mode*. The rules established for this are as follow:

1. The second note must form a second major above the tonic, the fourth note and the dominant should form a fourth and fifth exactly true; and this equally in both modes.

2. In the major mode, the mediant or third, the fifth and the seventh from the tonic, should always be major; or by this the mode is characterized. For the same reason these three intervals ought always to be minor in the minor mode: nevertheless, as it is necessary that the sensible note should likewise there be perceived, which cannot be effected without a false relation whilst the sixth note still remains minor; this occasions exceptions, of which in the course of the air or harmony care must be taken. But it is always necessary that the clef, with its transpositions, should preserve all the intervals, as determined with relation to the tonic, according to the species of the *mode*. For this a general rule will be found at the word *Clef* in Rousseau's Musical Dictionary.

As all the natural chords in the octave of *ut* give, with relation to that tonic, all the intervals prescribed for the major *mode*, and as the case is the same with the octave of *la* for the minor mode, the preceding example, which was only given that we might have an opportunity of naming the notes, may likewise serve as a formula for the rule of the intervals in each *mode*.

This rule is not, as one might imagine, established upon principles that are merely arbitrary: it has its source in the generation of harmony, at least in a certain degree. If you give a perfect major chord to the tonic, to the dominant, and the sub-dominant, you will have all the founds of the diatonic scale for the major *mode*: to obtain that of the minor, leaving still its third major to the dominant, give a third minor to the two other chords. Such is the analogy of the mode.

As this mixture of major and minor chords introduces into the minor mode a false relation between the sixth and the sensible note, to avoid this false relation, they sometimes give the third major to the fourth note in ascent, or the third minor to the dominant in descending, chiefly by inverting the chords; but these in this case are licences.

There are properly no more than two *modes*, as we have seen: but as there are twelve different founds in the octave which may be made fundamental founds, and of consequence form as many keys or tones; and as each of these tones are susceptible of the major or minor mode, music may be composed in twenty-four modes or manners. Nay, in the manner of writing music, there are even thirty-four passable modes: but in practice ten are excluded, which when thoroughly examined are nothing else but a repetition of the other ten, under relations much more difficult, in which all

the



Mode. the chords must change their names, and where it must cost any one some trouble to know what he is about. Such is the major mode upon a note raised above its natural pitch by a semitone, and the minor mode upon a note depressed by a semitone. Thus, instead of composing upon *sol* sharp with a third major, it is much more eligible to operate upon *la* flat, which will give you an opportunity to employ the same tones; and instead of composing upon *re* flat with a third minor, you will find it more convenient to choose *ut* sharp for the same reason; viz. on one hand to avoid a *fa* with a double sharp, which would be equivalent to a *sol* natural; and on the other hand a *fi* with a double flat, which would become a *la* natural.

The composer does not always continue in the same mode, nor in the same key, in which he has begun an air; but, whether to alter the expression or introduce variety, modes and keys are frequently changed, according to the analogy of harmony; yet always returning to those which have been first heard: this is called modulation.

From thence arises a new division of modes into such as are principal and such as are relative: the principal is that in which the piece begins and ends; the relative modes are such as the composer interweaves with the principal in the flow of the harmony. (See MODULATION).

Others have proposed a third species, which they call a mixed mode, because it participates the modulation of both the others, or rather because it is composed of them; a mixture which they did not reckon an inconvenience, but rather an advantage, as it increases the variety, and gives the composer a greater latitude both in air and harmony.

This new mode, not being found by the analysis of the three chords like the two former, is not determined, like them, by harmonics essential to the mode, but by an entire scale which is peculiar to itself, as well in rising as descending; so that in the two modes above-mentioned the scale is investigated by the chords, and in this mixed mode the chords are investigated by the scale. The following notes exhibit the form of this scale in succession, as well rising as descending:

*mi fa sol la si ut re mi.*

Of which the essential difference is, as to the melody, in the position of the two semitones; of which the first is found between the first and the second note, and the last between the fifth and sixth: and, with respect to the harmony, the difference consists in this, that upon its tonic it carries a third minor in the beginning, and major in ending, in the accompaniment of this scale, as well in rising as descending, such as it has been given by those who proposed it, and executed at a spiritual concert, May 30. 1751.

They object to its inventor, That his mode has neither chords nor harmony essential to itself, nor cadences which are peculiar to it, and which sufficiently distinguish it from the major or minor mode. He answers to this, That the distinction of his mode is less in harmony than in melody, and less even in the mode itself than in the modulation; that in its beginning it is distinguished from the major mode by its third minor, and in its end from the minor mode by its plagal

cadence. To which his opponents reply, That a modulation which is not exclusive cannot be sufficient to establish a mode; and that his must inevitably occur in the two other modes, and above all in the minor: and, as to his plagal cadence, that it necessarily takes place in the minor mode as often as transition is made from the chord of the tonic to that of the dominant, as has long been the case in practice, even upon final notes, in plagal modes, and in the tone proper to the fourth. From whence it is concluded, that his mixed mode is not so much a particular species, as a new denomination for the manner of interweaving and combining the major and minor modes, as ancient as harmony, practised at all periods: and this appears to be so true, that, even when he begins his scale, its author will neither venture to give the fifth nor the sixth to his tonic, for fear left by the first the tonic should be determined in the minor mode, or the mediant in the major mode by the second. He leaves the harmony equivocal by not filling up his chord.

But whatever objections may be made against the mixed mode, whose name is rather rejected than its practice, this will not prevent the author from appearing as a man of genius, and a musician profoundly learned in the principles of his art, by the manner in which he treats it, and the arguments which he uses to establish it.

MODE Major. } See INTERVAL.  
MODE Minor. }

MODEL, in a general sense, an original pattern, proposed for any one to copy or imitate.

This word is particularly used, in building, for an artificial pattern made in wood, stone, plaster, or other matter, with all its parts and proportions, in order for the better conducting and executing some great work, and to give an idea of the effect it will have in large. In all great buildings, it is much the surest way to make a model in relief, and not to trust to a bare design or draught. There are also models for the building of ships, &c. and for extraordinary staircases, &c.

They also use models in painting and sculpture; whence, in the academies, they give the term *model* to a naked man or woman, disposed in several postures, to give an opportunity to the scholars to design him in various views and attitudes.

MODENA, a duchy of Italy, bounded on the south by Tuscany and the republic of Lucca, on the north by the duchy of Mantua, on the east by the Bolognese and the territories of the church, and on the west by the duchy of Parma; extending in length from south to north about 56 English miles, and in breadth between 24 and 36, and yielding plenty of corn, wine, and fruits, with mineral waters. In some places also petroleum is skimmed off the surface of the water of deep wells made on purpose; and in others is found a kind of earth or tophus, which, when pulverised, is said to be an excellent remedy against poison, fevers, dysenteries, and hypochondriac disorders. The country of La Salla affords several kinds of petrifications. The principal rivers are the Crostolo, Secchia, and Panaro. The family of Este, dukes of Modena, is very ancient. They had their name from Esté, a small city in the district of Padua.

**Modena** In 1753, the present duke was appointed imperial vicar-general, field-marshal, and governor, of the Milanese during the minority of the archduke Peter Leopold, who was declared governor-general of the Austrian Lombardy. The duke, though a vassal of the empire, hath an unlimited power within his own dominions.

**Modillon:** **MODENA**, an ancient city, in Latin *Mutina*, which gives name to a duchy of Italy, and is its capital. It stands 28 miles east of Parma, 44 almost fourth of Mantua, and 20 west of Bologna; and is a pretty large and populous, but not a handsome city. It is much celebrated by Roman authors for its grandeur and opulence; but was a great sufferer by the siege it underwent during the troubles of the triumvirate. It hath long been the usual residence of the dukes; and is also the see of a bishop, who is suffragan to the archbishop of Bologna. Mr Keyler says, that when Decius Brutus was besieged here by Mark Antony, Hirtius the consul made use of carrier-pigeons; and that, even at this day, pigeons are trained up at Modena, to carry letters, and bring back answers. This city hath given birth to several celebrated persons, particularly Tasso the poet, Correggio the great painter, Sigonius the civilian and historian, da Vinci the architect, and Montecuculi the imperial general. The tutelary saint of it is named *Geminianus*. The ducal palace is a very noble edifice, in which, among the other fine pictures, the birth of Christ by Correggio, called *la Notte Felice*, is much celebrated. The only manufacture for which this city is noted, is that of masks, of which great numbers are exported. The churches of the Jesuits, of the Theatines, and of St Dominic, are well worth viewing. In the college of St Carlo Boromeo between 70 and 80 young noblemen are continually maintained, and instructed both in the sciences and genteel exercises. St Beatrix, who was of the family of Esté, is said to knock always at the gate of the palace three days before any of the family dies. Before most of the houses are covered walks, or porticos, as at Bologna. The city is fortified, and on its south side stands the citadel.

**MODERATOR**, in the schools, the person who presides at a dispute, or in a public assembly; the president of the annual assembly of the church of Scotland is styled *moderator*.

**MODERN**, something new, or of our time; in opposition to what is antique, or *ancient*.

**MODERN Authors**, according to Naude, are all those who have wrote since Boëthius. The modern philosophy commences with Galileo; the modern astronomy with Copernicus.

**MODIFICATION**, in philosophy, that which modifies a thing, or gives it this or that manner of being. Quantity and quality are accidents, which modify all bodies.

*Decree of MODIFICATION*, in Scots law, a decree ascertaining the extent of a minister's stipend, without proportioning it among the persons liable in payment.

**MODILLIONS**, in architecture, ornaments in the cornice of the Ionic, Corinthian, and Composite columns.

**MODIUS**, in antiquity, a kind of dry measure, in

use among the Romans, for several sorts of grain.

**MODREVIUS** (Andreas Frichius), secretary to Sigismund Augustus king of Poland, acquired considerable reputation by his learning and works. He broke off from the Romish church, favoured the Lutherans and Anti-trinitarians, and took great pains in order to unite all Christian societies under the same communion. Grotius has placed him in the class of the reconcilers of the different schemes of religion. His principal work is intitled, *De republica emendanda*.

**MODULATION**, the art of forming any thing to certain proportion.

**MODULATION**, in reading, or speaking. See **READING**.

**MODULATION**, in music, derived from the Latin *modulari*. This word in our language is susceptible of several different significations. It frequently means no more than an air, or a number of musical sounds properly connected and arranged. Thus it answers to what Mr Malcolm underlands by the word *tunes*, when he does not expressly treat concerning the tuning of instruments. Thus likewise it expresses the French word *chant*; for which reason, in the article Music, we have frequently expressed the one word by the other. But the precise and technical acceptation to which it ought to be confined, is the art of composing melody or harmony agreeably to the laws prescribed by any particular key, that of changing the key, or of regularly and legitimately passing from one key to another. In what remains to be said upon the subject we follow Rousseau.

Modulation (says he) is properly the manner of ascertaining and managing the modes; but at this time the word most frequently signifies the art of conducting the harmony and the air successively through several modes, in a manner agreeable to the ear and conformed to rules.

If the different modes be produced by harmony, from thence likewise must spring the laws of modulation. These laws are simple in conception, but difficult in practice. We proceed therefore to shew in what they consist.

To modulate properly in the same tone, it is necessary, 1. To run through all the sounds of it in an agreeable air, frequently repeating the sounds which are most essential to it, and dwelling upon these sounds with the most remarkable emphasis; that is to say, that the chord containing the sensible notes, and that of the tonic, should frequently be heard in it, but under different appearances, and obtained by different procedures to prevent monotony. 2. That rests or cadences should only be established upon these two chords: the greatest liberty, however, which ought to be taken with the rule is, that a cadence or repose may be established on the chord of the subdominant. 3. In short, that none of the sounds of the mode ought ever to be altered; for without quitting it, we cannot introduce a sharp or a flat which does not belong to it, nor abstract any one which in reality does belong to it.

But passing from one mode to another, we must consult analogy, we must consider the relations which a key bears to the other notes in the series, and to the num-

Modulation number of sounds common to both the modes, that from whence we pass, and that into which we enter.

If we pass from a mode major, whether we consider the fifth from the key as having the most simple relation with it except that of the octave, or whether we consider it as the first found which enters into the harmonics of the same key, we shall always find, that this fifth, which is the dominant of the mode, is the chord upon which we may establish the modulation most analogous to that of the principal key.

This dominant, which constituted one of the harmonics of the first key, makes also one of its own peculiar key, of which it is the fundamental sound. There is then a connection between these two chords. Besides, that same dominant carrying, as well as the tonic, a perfect chord major upon the principle of resonance, these two chords are only differing one from the other by the dissonance, which passing from the key to the dominant is the sixth superadded, and when reascending from the dominant to the key is the seventh. Now these two chords, thus distinguished by the dissonance which is suitable to each, by the sounds which compose them when ranged in order, form precisely the octave, or the diatonic scale, which we call a *gammut*, which determines the mode.

This same series of the key, altered only by a sharp, forms the scale belonging to the mode of the dominant; which shows how striking the analogy is between these two tones, and gives the easiest opportunity of passing from one to the other by means of one single alteration alone. The mode then of the dominant is the first which presents itself after that of the key in the order of modulations.

The same simplicity of relations which we find between a tonic and its dominant, is likewise found between the same tonic and its sub-dominant; for that fifth, in ascending, which is formed by the dominant with the tonic, is likewise formed by the sub-dominant in descending: but that sub-dominant does not form a fifth with the tonic, except by inversion; it is directly a fourth, if we take that tonic below, as it ought to be; and which fixes the degree of their relations: for in this sense the fourth, whose ratio is as 3 to 4, immediately follows the fifth, whose ratio is as 2 to 3. So that, if that sub-dominant does not enter into the chord of the tonic, in return the tonic enters into its perfect chord. For let *ut mi sol* be the chord of the tonic, that of the sub-dominant shall be *fa la ut*: thus it is the *ut* which here forms the connection, and the two other sounds of this new chord are exactly the two dissonances of the preceding. Besides, we need not alter more sounds for this new mode than for that of the dominant; they are both in the one and the other quite the same chords of the principal mode, except one. Add a flat to the sensible note *fi* or *B*, and all the notes in the mode of *ut* or *C* will serve for that of *fa* or *F*. The mode of the sub-dominant then is scarcely less analogous to the principal mode than that of the dominant.

It ought likewise to be remarked, that after having made use of the first modulation in order to pass from a principal mode *ut* or *C*, to that of the dominant *sol* or *G*, we are obliged to make use of the second to return to the principal mode: for if *sol*, or *G*, be the dominant in the mode of *ut* or *C*, *ut* is the sub-domi-

nant in the mode of *sol*: thus one of these modulations is no less necessary than the other.

The third sound which enters into the chord of the tonic is that of third formed by its mediant; and, after the preceding, it is likewise the most simple of relations  $\frac{3}{2}$ . Here then is a new modulation which presents itself, and which is so much the more analogous, because two of the sounds of the principal tonic enter likewise into the minor chord of its mediant; for the former chord being *ut mi sol*, the latter must be *mi sol fa*, where it may be perceived that *mi* and *sol* are common. But what renders this modulation a little more remote, is the number of sounds which are necessary to be altered, even for the minor mode, which is most suitable to this *mi*. In the article *MUSIC* (234.) will be found a table for all the modes; and Rousseau, in his *Musical Dictionary*, has given the formula of a scale both for the major and minor: now, by applying this formula to the minor mode, we find nothing in reality, but the fourth found *fa* heightened by a sharp in descending; but in rising, we find two others which are altered, *viz.* the principal tonic *ut*, and its second *re*, which here becomes a sensible note: it is certain that the alteration of so many sounds, and particularly of the tonic, must remove the mode and weaken the analogy.

If we should invert the third as we have inverted the fifth, and take that third below the tonic on the sixth note *la*, which ought here to be called a *sub-médiant*, or the *médiant below*, we shall form upon this note *la* a modulation more analogous to the principal tone than that of *mi*; for as the perfect chord of this sub-médiant is *la ut mi*, there once more we find, as in that of the mediant, two of the sounds which enter into the chord of the tonic, *viz. ut* and *mi*: and moreover, since the scale of this new key is composed, at least in descending, of the same sounds with that of the principal key; and since it has only two sounds altered in ascending, that is to say, one fewer than the series of the mediant; it follows that the modulation of this sixth note is preferable to that of the mediant; and by so much the more, that there the principal tonic forms one of the sounds essential to the mode; which is more proper for approximating the idea of the modulation. The *mi* may afterwards follow.

Here then are four sounds, *mi fa sol la*, upon each of which we may modulate in passing from the major mode of *ut*. *Re* and *fi* remain, which are the two harmonics of the dominant. This last, as being a sensible note, cannot become a tonic by any proper modulation, at least it cannot immediately become one: this would be an abrupt application of ideas too much opposed to the same sounds, and would likewise be to give it a harmony too remote from the principal found. As to the second note *re*, we may likewise, by favour of a consonant procedure in the fundamental bass, modulate upon it in a third minor; but this must be only continued for an instant, that the audience may not have time to forget the modulation of *ut*, which is itself altered in that place; otherwise, instead of returning immediately to *ut*, we must pass through intermediate modes, where we must run great hazard of deviation.

By following the same analogies, we may modulate in the following order, to make our exit from a minor mode;

mode; first upon the mediant, afterwards the dominant, next the sub-dominant, then the sub-mediator, or sixth note. The mode of each of these accessory keys is determined by its mediant taken from the principal found. For instance, issuing from the major mode of *ut*, to modulate upon its mediant, we render the mode of that mediant minor; because *sol*, the dominant of the principal found, forms a third minor with that mediant, which is *mi*. On the contrary, in our egress from the minor mode of *la*, we modulate upon its mediant *ut* in the major mode; because *mi*, the dominant of the tone from whence we issue, forms a third major with the key of that into which we enter, &c.

These rules, comprehended in one general formula, import, that the modes of the dominant and of the sub-dominant are like that of the tonic, and that the mediant and the sixth note require a mode opposed. We must, however, remark, that, by the right which we have of passing from the major to the minor, and *vice versa*, upon the same key, we may likewise change the order of modes from one key to another; but whilst we thus remove ourselves from the natural modulation, we must presently think of our return: for it is a general rule, that every piece of music ought to terminate in that key with which it began.

In his Musical Dictionary, plate B, fig. 6. and 7. Rousseau has collected in two examples, which are very short, all the modes to which we may immediately pass; the first, in passing from the major mode; and the second, from the minor. Each note indicates a particular modulation; and the value of the notes in each example likewise shows the relative duration suitable to each of these modes, according to its relation with the principal mode.

These immediate transitions from one mode to another, furnish us with the means of passing by the same rules to modes still more remote, and from thence to return to the principal mode, of which we never should lose sight. But it is not sufficient to know what course we ought to pursue; we must likewise be acquainted with the method of entering into it. A summary therefore of the precepts which are given in this department shall immediately follow.

In melody, in order to discover and introduce the modulation which we have chosen, nothing is necessary but to render perceptible the alterations which it causes in the sounds of that mode from whence we issue, to make them proper for the mode into which we enter. Are we now in the major mode of *ut*? there needs no more than to found the note *fa* sharp, that we may discover the mode of the dominant; or a *si* flat, that we may shew the mode of the sub-dominant. Afterwards you may run over the sounds essential to the mode in which you enter; if it is well chosen, your modulation will always be just and regular.

In harmony, the difficulty is a little increased: for as it is necessary that the change of modes should be made at the same time through all the parts, care must be taken of the harmony, and of the air, that we may avoid pursuing different modulations at the same time. Huygens has happily remarked, that the prohibition of two fifths in immediate succession proceeds upon this rule as its principal: in reality, between two parts it is scarcely possible to form a number of just fifths in uninterrupted succession without operating in two dif-

ferent modes.

To introduce a mode, a great many pretend that it is sufficient to form the perfect chord of its principal found, and this is indispensable in order to produce the mode. But it is certain, that the mode cannot be exactly determined but by the chord containing the sensible note, or the dominant: we must then cause this chord to be heard when we enter into a new modulation. The most eligible rule would be, That in it the seventh, or minor dissonance, should always be prepared, at least the first time in which it is heard: but this method is not practicable in every admissible modulation; and provided that the fundamental bass proceeds by consonant intervals, that the connection of harmony be observed, the analogy of the mode pursued, and false relations avoided, the modulation will always be approved. Composers prescribe as another rule, That a mode should not be changed except after a perfect cadence: but this interdict is useless, and no person observes it.

All the possible methods of passing from one mode to another, are reducible to five with respect to the major mode, and to four with respect to the minor; which, in the Musical Dictionary, plate B, fig. 8. will be found implied in a fundamental bass intended for each modulation. If there be any other modulation which cannot be resolved into some one of these nine, unless that modulation be enharmonic, it must infallibly be illegitimate. See ENHARMONIC.

MODULE, in architecture, a certain measure, or bigness, taken at pleasure, for regulating the proportions of columns, and the symmetry or disposition of the whole building. Architects generally choose the semidiameter of the bottom of the column for their module, and this they subdivide into parts or minutes.

MOEBIUS (Godfrey), professor of physic at Iena, was born at Lauch in Thuringia in 1611. He became first physician to Frederic William elector of Brandenburg, to Augustus duke of Saxony, and to William duke of Saxe-Weimar. He wrote several medicinal works, which are esteemed; and died at Halle, in Saxony, in 1664.

MOENIUS (Caius), a celebrated Roman consul, conqueror of the ancient Latins, 338 B. C. He was the first who hung up the prows, &c. of the galleys he had taken at the naval engagement of Actium, upon the place where the tribunes harangued the people; from whence it was called the *prostra*.

MOFFAT, a village of Scotland, in the shire of Annandale, 36 miles south-west of Edinburgh; famous for its sulphureous waters; one of the springs being used for bathing, the other for drinking. These waters are of great service in gripings of the guts, colics, and pains in the stomach. Those who are troubled with obstructions, rheumatic pains, and aches, find great relief both from bathing and drinking. The water is also of great use in scorbutic and scrophulous cases.

MOGULS, or MUNGLS, a celebrated nation of Asia, whose conquests formerly were the most rapid and extensive of any people recorded in history.

The origin of the Moguls, Tartars, and Turks, is universally allowed to be the same; and they are considered as the offspring of part of the ancient Scythians.

Moguls. thians. They themselves deduce their origin from Japhet, or, as they call him, *Japhis*, the son of Noah. His son Turk, they say, was the first king, or khan, of those nations who are now known by the separate names of *Turks*, *Tartars*, and *Moguls*; and the Tartars especially, assert that their proper designation is *Turks*. To this phrase is attributed many of those inventions which barbarous nations commonly ascribe to their first sovereigns. He was succeeded by Taunak; in whose reign the whole posterity of Turk were divided into four large tribes, denominated the *orda's* of Erlat, Gialair, Kaugin, Berlas, or Perlas; of which last came the famous Timur Beg, or Tamerlane. From this time to that of Alanza Khan, we meet with nothing remarkable. In his reign the Turks being immersed in all kinds of luxury, universally apostatized into idolatry. Having two sons, Tartar and Mogul, he divided his dominions among them, and thus gave rise to the two empires of the Tartars and Moguls.

The two nations had not long existed before they began to make war upon each other: and after long contention, the event at last was, that Il Khan, emperor of the Moguls, was totally overthrown by Siuntz Khan, emperor of the Tartars; and so great was the defeat, that the Mogul nation seems to have been almost exterminated. Only two of Il Khan's family survived this disaster. These were Kajan his youngest son, and Nagos his nephew, who were both of an age, and had both been married the same year. These two princes, with their wives, had been taken prisoners by Siuntz Khan, but found means to make their escape to their own country. Here they seized upon all the cattle which had not been carried off by the Tartars; and which was easily done, as having none to dispute the property with them; then stripping some of the slain, they took their clothes, and retired into the mountains. They passed several mountains without much difficulty; but at last advanced to the foot of one exceedingly high, which had no way over it but a very small path made by certain animals, called in the Tartar language *archara*. This path they found themselves obliged to make use of, tho' it was so strait, that only one could pass at a time, and he was in the most imminent danger of breaking his neck at the least false step. Having ascended the mountain on one side by this path, they descended by the same on the other side; and were agreeably surpris'd to find themselves in a most delightful track, interpersed with rivulets and charming meadows, abounding with a vast variety of delicious fruits, and inclosed on all sides by inaccessible mountains, in such a manner as to shelter them from all future pursuits of the Tartars. Here they lived some time, and gave this beautiful country the name of *Irgana-kon*, in allusion to its situation; *Irgana* signifying, in the old language of the Moguls, a "valley," and *Kon*, a "steep height."

In process of time these two families very much increased. Kajan, whose posterity was the most numerous, called his descendants *Kajath*: but the people springing from Nagos were divided into two tribes; one of which received the appellation of *Nagofser*, and the other that of *Durlagan*.

These two Mogul princes and their descendants lived in this place for more than 400 years; but the latter then finding it too narrow for them, meditated a re-

turn to the country from which their forefathers had been driven. For some time, however, they found this impracticable, as the path that conducted their ancestors had been long since destroyed. At last they discovered, that one part of the high mountain above-mentioned was not very thick in a certain place; and also, that it consisted entirely of iron ore. To this, having before set fire to a layer of wood, and another of charcoal, laid along the foot of the mountain, they applied 70 large bellows, and at last melted the mountain in such a manner, that an opening was made large enough for a loaded camel to pass; and through this passage they all marched out with great joy.

The Moguls having thus issued as it were from a new world, overthrew the Tartars in their turn; and continued to be a very considerable nation till the time of their great hero Temujin, afterwards called *Jenghis Khan*, whom they extol in the most extravagant manner. It is difficult, however, to say, at the time Temujin made his appearance, how far the dominions of the Moguls extended, or in what estimation they were held by their neighbours. It seems to be pretty certain, that great part of the vast region now known by the name of *Tartary*, was then in a state of considerable civilization, and likewise extremely populous, as we find mention made of many cities which the Moguls destroyed; and the incredible multitudes whom they slaughtered, abundantly shew the populousness of the country. On the east, the country of the Moguls and Tartars had the great desert which divides Tartary from China; on the west, it had the empire of Karazum founded by Mahmud Gazni; and on the south were the countries now known by the name of *Indyflan*, *Siam*, *Pegu*, *Tonquin*, and *Cochin-China*. Thus it comprehended the eastern part of modern Tartary, and all Siberia. This whole region was divided among a great number of *Aymacks*, or *tribes*; who had each one or more khans, according as it was more or less numerous, or divided into branches. Among these, that of the *Kara-its* was the most powerful: their prince assumed the title of *Grand Khan*, and among the rest the Moguls were tributary to him; but, according to the Chinese historians, both the one and the other were tributary to the emperor of Kitay or Katay. China was divided into two parts: the nine southern provinces were in the hands of the Chinese emperors of the Song dynasty, who kept their court at Hang-chew, the capital of the province of Chekyang: the five northern provinces, excepting part of Skenfi, were possessed by the Kin, a people of Eastern Tartary, from whom are descended the Manchew Tartars, at present masters of China. This vast dominion was named *Kitay*, or *Katay*, and was divided into two parts: that which belonged to China, was properly called *Kitay*; and the part, which belonged to Tartary, was called *Karakitay*; in which some even include the territories of the Moguls, Kararits, and other tribes, which are the subject of the present history. The western part of the empire of Kitay was possessed by a Turkish prince, who had lately founded a new kingdom there, called *Hya*; whose capital city was Hya-chew, now Ninghya in Shenfi, from whence the kingdom took its name. To the west of Hya lay Tangut; a country of great extent, and formerly very powerful; but at that time reduced to a low state, and di-

Moguls.

Moguls de-  
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from Ja-  
phet.

Almost ex-  
terminated  
by the Tar-  
tars.

They arrive  
in a de-  
lightful val-  
ley.

From  
whence  
they at last  
issued, and  
of their great  
hero Temujin,  
afterwards  
called Jenghis  
Khan, whom  
they extol in  
the most extra-  
vagant man-  
ner. It is diffi-  
cult, however,  
to say, at the  
time Temujin  
made his ap-  
pearance, how  
far the domi-  
nions of the  
Moguls ex-  
tended, or in  
what estima-  
tion they were  
held by their  
neighbours.

State of A-  
sia at the  
time of  
Jenghis  
Khan.

Mogul. divided among many princes; some of whom were subject to the emperor of Hys, and others to the emperor of China. All Tartary to the westward, as far as the Caspian sea, with the greater part of Little Buckharia, which then passed under the general name of *Turkestan*, was subject to Gorkhan, Khurkhan, or Kavar Khan; to whom even the Gazni monarchs are said to have been tributary. This Ghurkhan had been prince of the Western Kitan or Lyau; who, driven out of Kitay by the King, settled in Little Buckharia, and the country to the north, where they founded a powerful state about the year 1124.

6 Defendant and birth of Temujin. Thus the Moguls, properly so called, had but a very small extent of empire which could be called their own, if indeed they had any, when Temujin made his appearance. This hero is said by the Tartars to have been of divine origin, since his family could be traced no farther back than ten generations, the mother of whom was got with child by a spirit. The names and transactions of his predecessors are equally uncertain and unimportant: he himself, however, was born in the year 1163, and is said to have come into the world with congealed blood in his hands; from whence it was prognosticated that he would be a great warrior, and obtain the victory over all his enemies.

This prediction, if any such there was, Temujin most literally fulfilled. At the time of his father's decease, his subjects amounted to between 30,000 and 40,000 families; but of these two thirds quickly deserted, and Temujin was left almost without subjects.

7 Subdues his subjects by means of Vang Khan. When only 13 years of age, he fought a bloody battle against these revolters; but either was defeated, or gained an indecisive victory; so that he remained in obscurity for 27 years longer. His good fortune at last led him owed to the friendship of Vang Khan, who ruled over a great number of Tartar tribes to the north of Kitay, and has been heard of under the name of *Prefter John* among the Europeans. This prince took Temujin under his protection; and a rebellion being afterwards raised against himself, Temujin was made his general, and the khan was kept in possession of his throne; soon after which, Temujin subdued the tribes which had revolted from himself, treating them at the same time with the utmost barbarity.

8 Who becomes jealous, and contrives his destruction. This happened in the year 1201; but Vang Khan, instead of continuing the friend of Temujin, now became jealous, and resolved to destroy him by treachery. With this view he proposed a marriage between Temujin's son Jaji and his own daughter, and another between Temujin's daughter and his own son. Temujin was invited to the camp of Vang Khan, in order to celebrate this double marriage; but, receiving intelligence of some evil intention against him, he excused himself to Vang Khan's messengers, and desired that the ceremony might be put off to some other time.

A few days after the departure of these messengers, Badu and Kislik, two brothers, who kept the herds of one of Vang Khan's chief domestics, came and informed Temujin, that the grand Khan finding he had missed his aim, was resolved to set out instantly, and surprise him next morning, before he could suspect any danger. Temujin, alarmed at this intelligence, quitted his camp in the night-time, and retired with all his people to some distance. He was scarce gone, when Vang Khan's troops arrived, and discharged an incre-

Mogul. dible number of arrows among the empty tents; but finding nobody there, they pursued Temujin in such haste that they fell into great disorder. In this condition they were suddenly attacked and routed by Temujin, after which an open war with Vang Khan took place.

9 Temujin overcomes all his enemies. By this quarrel almost all the princes of Tartary were put in motion; some siding with Temujin, and others with Vang Khan. But at last fortune declared in favour of the former: Vang Khan was overthrown in a battle, where he lost 40,000 men; and obliged to fly for refuge to a prince named *Tayyan Khan*, who was Temujin's father-in-law, and his own enemy, and by whom he was ungenerously put to death. Temujin immediately began to seize on his dominions, great part of which voluntarily submitted: but a confederacy was formed against him by a number of Vang Khan's tributaries, at the head of whom was Jamuka, a prince who had already distinguished himself by his enmity to Temujin; and even Tayyan Khan himself was drawn into the plot, through jealousy of his son-in-law's good fortune. But Temujin was well prepared; and in the year 1204 attacked Tayyan Khan, entirely routed his army, killed himself, and took Jemuka prisoner, whose head he caused instantly to be struck off; after which he marched against the other tribes who had conspired against him. Them he quickly reduced; took a city called *Kashin*, where he put all to the sword who had borne arms against him; and reduced all the Mogul tribes in 1205.

10 Assumes the title of Jenghiz Khan. Temujin now, having none to oppose him, called a general diet, which he appointed to be held on the first day of the spring 1206; that is, on the day in which the sun entered Aries. To this diet were summoned all the great lords both Moguls and Tartars; and in the mean time, to establish good order in the army, he divided his soldiers into bodies of 10,000, 1000, 100, and 10 men, with their respective officers, all subordinate to the generals, or those who commanded the bodies of 10,000; and these were to act under his own sons. On the day of holding the diet, the princes of the blood and great lords appeared dressed in white. Temujin, dressed in the same manner, with his crown on his head, sat down on his throne, and was complimented by the whole assembly, who wished him the continuance of his health and prosperity. After this they confirmed the Mogul empire to him and his successors; adding all those kingdoms which he had subdued, the descendants of whose vanquished khans were deprived of all right or title to them; and after this he was proclaimed emperor with much ceremony. During this inauguration, a pretended prophet declared that he came from God to tell the assembly, that from thenceforth Temujin should assume the name of *Jenghiz Khan*, or the *Most Great Khan of khans*; prophesying also, that all his posterity should be khans from generation to generation. This prophecy, which was no doubt owing to Temujin himself, had a surprising effect on his subjects, who from that time concluded, that all the world belonged of right to them, and even thought it a crime against heaven for any body to pretend to resist them.

Jenghiz Khan having now reduced under his subjection all the wandering tribes of Moguls and Tartars, began to think of reducing those countries to the south

<sup>11</sup> Mogul. south and south-west of his own, where the inhabitants were much more civilized than his own subjects; and the countries being full of fortified cities, he must of course expect to meet with more resistance. He began with the emperor of Hya, whose dominions he invaded in 1209, who at last submitted to become his tributary. But in the mean time Jenghiz Khan himself was supposed to be tributary to the emperor of Kitay; who, in 1210, sent him an officer, demanding the customary tribute. This was refused with the utmost indignation, and a war commenced, which ended not but with the dissolution of the empire of Kitay, as mentioned under the article CHINA, n<sup>o</sup> 17—33.

In the year 1216 Jenghiz Khan resolved to carry his arms westward, and therefore left his general Muchuli to pursue his conquests in Kitay. In his journey westward he overthrew an army of 300,000 Tartars who had revolted against him; and, in 1218, sent ambassadors desiring an alliance with Mohammed Karazm Shah, emperor of Gazna. His ambassador was haughtily treated: however, the alliance was concluded; but soon after broken, through the treachery, as it is said, of the Karazmian monarch's subjects. This brought on a war attended with the most dreadful devastations, and which ended with the entire destruction of the empire of Karazm or Gazna, as related under the article GAZNA.

After the reduction of Karazm, part of the Moguls broke into Iran or Persia, where also they made large conquests, while others of their armies invaded Georgia and the countries to the west; all this time committing such enormities, that the Chinese historians say, both men and spirits burst with indignation. In 1225, Jenghiz Khan returned to Hya, where he made war on the emperor for having sheltered some of his enemies. The event was, that the emperor was slain, and his kingdom conquered, or rather destroyed; which, however, was the last exploit of this most cruel conqueror, who died in 1227, as he marched to complete the destruction of the Chinese.

<sup>12</sup> Vast extent of his empire.

The Mogul empire, at the death of Jenghiz Khan, extended over a prodigious tract of country; being more than 1800 leagues in length from east to west, and upwards of 1000 in breadth from north to south. Its princes, however, were still insatiable, and pushed on their conquests on all sides. Oktay was acknowledged emperor after Jenghiz Khan; and had under his immediate government Mogulestan, (the country of the Moguls properly so called), Kitay, and the countries eastward to the Tartarian sea. Jagatay his brother governed under him a great part of the western conquests. The country of the Kipjacks, and others to the east and north-east, north and north-west, were governed by Batu or Patu the son of Juji, who had been killed in the wars; while Tuli or Toley, another son of Jenghiz Khan, had Khorassan, Persia, and what part of India was conquered. On the east side the Mogul arms were still attended with success; not only the empire of Kitay, but the southern part of CHINA, was conquered, as already related under that article, n<sup>o</sup> 23—40. On the west side matters continued much in the same way till the year 1254, when Magu, or Menkho, the fourth khan of the Moguls, (the same who was afterwards killed at a siege in China \*), raised a great army, which he gave

to his brother Hulaku, or Hulagu, to extend his dominions westward. In 1255 he entered Iran; where he suppressed the Ismaelians or Assassins; of whom an account is given under the article ASSASSINS; and two years afterwards he advanced to Bagdad, which he took, and cruelly put the Khalif to death, treating the city with no more lenity than the Moguls usually treated those which fell into their hands. Every thing was put to fire and sword; and in the city and its neighbourhood, the number of slain, it is said, amounted to 1,600,000.—The next year he invaded Syria; the city of Damafcus was delivered up, and, as it made no resistance, the inhabitants were spared; but Aleppo being taken by storm, a greater slaughter ensued there than had taken place at Bagdad, not even the children in their cradles being spared. Some cities of this country revolted the next year, or the year after; but falling again into the hands of the Moguls, they were plundered, and the inhabitants butchered without mercy, or carried into slavery.

Hulaku died in 1264, and at his death we may fix the greatest extent of the Mogul empire. It now comprehended the whole of the continent of Asia, excepting part of Indostan, Siam, Pegu, Cochinchina, and a few of the countries of Lesser Asia, which had not been attacked by them; and during all these vast conquests no Mogul army had ever been conquered, except one by Jaloloddin, as mentioned under the article GAZNA.—From this period, however, the empire began to decline. The ambition of the khans having prompted them to invade the kingdoms of Japan and Cochinchina, they were miserably disappointed in their attempts, and lost a great number of men.—The same bad success attended them in Indostan; and in a short time this mighty empire broke into several smaller ones. The governors of Persia being of the family of Jenghiz Khan, owed no allegiance to any superior; those of Tartary did the same. The Chinese threw off the yoke; and thus the continent of Asia wore much the same face that it had done before Jenghiz Khan began his conquests.

<sup>14</sup> It begins to decline.

The successors of Hulaku reigned in Persia till the year 1335; but that year Abufaid Khan, the eighth from Hulaku, dying, the affairs of that country fell into confusion for want of a prince of the race of Jenghiz Khan to succeed to the throne. The empire therefore was divided among a great number of petty princes, who fought against each other almost without intermission, till, in the year 1369, Timur Bek, or Tamerlane, one of these princes, having conquered a number of others, was crowned at Balkh, with the pompous title of *Sabek Karan*; that is, "the emperor of the age, and conqueror of the world." As he had just before taken that city, and destroyed one of his most formidable rivals who had shut himself up in it, the new emperor began his reign with beheading some of the inhabitants, imprisoning others, burning their houses, and selling the women and children for slaves.—In 1370 he crossed the Sihun, and made war on the Getes, and attacked Karazm. Next year he granted a peace to his enemies; but two years after, he again invaded the country of the Getes, and by the year 1379 had fully conquered that country as well as Korazan; and from that time he continued to extend his conquests in much the same manner as

<sup>15</sup> Tamerlane crowned emperor of Balkh.

<sup>16</sup> Becomes a great conqueror.

\* See China, n<sup>o</sup> 36.

Mogul.

Jenghiz Khan had done, though with less cruelty. In 1387 he had reduced Armenia, Georgia, and all Persia; the conquest of which last was completed by the reduction of Ispahan, 70,000 of the inhabitants of which were slaughtered on account of a sedition raised by some rash or evil-disposed persons.

17  
Troyades and  
conquers  
Indostan.

After the reduction of Persia, Timur turned his arms northward, and westward, subduing all the countries to the Euphrates. He took the city of Bagdad; subdued Syria; and having ravaged great part of Russia, returned to Persia in 1396, where he splendidly feasted his whole army. In 1398 he invaded Indostan, crossed the Indus on the 17th of September, reduced several fortresses, and made a vast number of captives. However, as he was afraid that, in case of any emergency, these prisoners might take part with the enemy, he gave orders to his soldiers to put all their Indian slaves to death; and, in consequence of this inhuman order, more than 100,000 of these poor wretches were slaughtered in less than an hour.

In the beginning of the year 1399, Timur was met by the Indian army; whom, after a desperate battle, he defeated with great slaughter, and soon after took the city of Delhi, the capital of the country. Here he seated himself on the throne of the Indian emperors; and here the sharis, kadis, and principal inhabitants of the city, came to make their submission, and begged for mercy. The tame elephants and rhinoceroses likewise were brought to kneel before him as they had been accustomed to do to the Indian emperors, and made a great cry as if they implored his clemency. These war-elephants, 120 in number, were, at his return, sent to Samarcand, and to the province where his sons resided. After this, at the request of the lords of the court, Timur made a great feast; at which he distributed presents to the princes and principal officers.

18  
The city of  
Delhi de-  
stroyed, and  
the inhabi-  
tants slaugh-  
tered.

Delhi at this time consisted of three cities, called *Seyri*, *Old Delhi*, and *Jehan Penah*. *Seyri* was surrounded with a wall in form of a circle. *Old Delhi* was the same, but much larger, lying south-west of the other. These two parts were joined on each side by a wall; and the third, lying between them, was called *Jehan Penah*, which was larger than *Old Delhi*. *Penah* had ten gates; *Seyri* had seven, three of which looked towards *Jehan Penah*; this last had thirteen gates, six to the north-west, and seven to the south-east. Every thing seemed to be in a quiet posture; when, on the 12th of January 1399, the soldiers of Timur being assembled at one of the gates of Delhi, insulted the inhabitants of the suburbs. The great emirs were ordered to put a stop to these disorders; but their endeavours were not effectual. The soltanas having a curiosity to see the rarities of Delhi, and particularly a famous palace adorned with 1000 pillars, built by an ancient king of India, went in with all the court; and the gate being on that occasion left open for every body, above 15,000 soldiers got in unperceived. But there was a far greater number of troops in a large place between Delhi, *Seyri*, and *Jehan Penah*, who committed great disorders in the two last cities. This made the inhabitants in despair fall on them; and many, setting fire to their houses, burnt their wives and children. The soldiers seeing this confusion, did nothing but pillage the houses; while the dis-

Mogul.

order was increased by the admission of more troops who seized the inhabitants of the neighbouring places, who had fled thither for shelter. The emirs, to put a stop to this mischief, caused the gates to be shut; but they were quickly opened by the soldiers within, who rose in arms against their officers; so that by the morning of the 13th the whole army was entered, and this great city was totally destroyed. Some soldiers carried out 150 slaves, men, women, and children; nay, some of their boys had 20 slaves a-piece to their share. The other spoils, in jewels, plate, and manufactures, were immense; for the Indian women and girls were adorned with precious stones, and had bracelets and rings on their hands, feet, and even toes, so that the soldiers were loaded with them. On the 15th, in *Old Delhi*, the Indians retired into the great mosque to defend themselves; but being attacked by the Tartars they were all slaughtered, and towers erected with their heads. A dreadful carnage now ensued throughout the whole city, and several days were employed before the inhabitants could be made to quit it entirely; and as they went, the emirs took a number of them for their service. The artisans were also distributed among the princes and commanders; all but the mafons, who were reserved for the emperor, in order to build him a spacious stone-mosque at Samarcand.

After this terrible devastation, Timur marched into the different provinces of Indostan, every where defeating the Indians who opposed him, and slaughtering the Ghebrs, or worshippers of fire. On the 25th of March he set out on his return, and on the 9th of May arrived at Samarcand. In a few months after his arrival, he was obliged to undertake an expedition into Persia, where affairs were in the utmost disorder on account of the misconduct of his son, whom he had appointed sovereign of that empire. Here Timur soon settled matters; after which he again set out on an expedition westward, reduced many places in Georgia which had not submitted before, and invaded and conquered Syria. At the same time he quarrelled with Bajazet the Turkish sultan, then busied in an enterprise against Constantinople, in which he would probably have succeeded had not Timur interposed. The cause of this quarrel at first was, that Bajazet had demanded tribute from a prince who was under Timur's protection, and is said to have returned an insulting answer to the Tartar ambassadors who were sent to him on that account. Timur, however, who was an enthusiast in the cause of Mahometanism, and considered Bajazet as engaged in the cause of heaven when besieging a Christian city, was very unwilling to disturb him in so pious a work; and therefore undertook several expeditions against the princes of Syria and Georgia, in order to give the Turkish monarch time to cool and return to reason. Among other places, he again invested the city of Bagdad, which had cast off its allegiance to him; and having taken it by storm, made such a dreadful massacre of the inhabitants, that 120 towers were erected with the heads of the slain. In the mean time Bajazet continued to give fresh provocation, by protecting one Kara Yuluf a robber, who had even insulted the caravan of Mecca; so that Timur at length resolved to make war upon him. The sultan, however, foreseeing the danger

19  
Timur  
quarrels  
with Bajazet  
the Turkish  
sultan.



Mogul. of bringing such a formidable enemy against himself, thought proper to ask pardon, by a letter, for what was past, and promise obedience to Timur's will for the future. This embassy was graciously received; and Timur returned for answer, that he would forbear hostilities, provided Bajazet would either put Kara Yusuf to death, send him to the Tartar camp, or expel him out of his dominions. Along with the Turkish ambassadors he sent one of his own; telling Bajazet that he would march into the confines of Anatolia, and there wait his final answer.

Though Bajazet had seemed at first willing to come to an agreement with Timur, and to dread his superior power; yet he now behaved in such an unsatisfactory manner, that the Tartar monarch desired him to prepare for war; upon which he raised the siege of Constantinople, and having met Timur with an army greatly inferior to the Tartars, was utterly defeated and taken prisoner. According to some accounts, he was treated with great humanity and honour; while others inform us, that he was shut up in an iron cage, against which he dashed out his brains the following year. At any rate, it is certain that he was not restored to liberty, but died in confinement.

This victory was followed by the submission of many places of the Lesser Asia to Timur; the Greek emperor owned himself his tributary, as did also the sultan of Egypt. After this Timur once more returned to Georgia, which he cruelly ravaged; after which he marched to Samarcand, where he arrived in the year 1405. Here, being now an old man, this mighty conqueror began to look forward to that state which at one time or other is the dread of all living creatures; and Timur, in order to quiet the remorses of his own conscience, came to the following curious resolution, which he communicated to his intimate friends; namely, that "as the vast conquests he had made were not obtained without *some violence*, which had occasioned the destruction of a great number of God's creatures, he was resolved, by way of atonement for his past crimes, to perform some good action; namely, to make war on the infidels, and exterminate the idolaters of China." This atonement, however, he did not live to accomplish; for he died the same year of a burning fever, in the 71<sup>st</sup> year of his age and 36<sup>th</sup> of his reign.

On the death of Timur, his empire fell immediately into great disorder, and the civil war continued for five or six years; but at last peace was restored, by the settlement of Shah Rukh, Timur's son, on the throne. He did not, however, enjoy the empire in its full extent, or indeed much above one half of it, having only Karazm, Khorassan, Kandahar, Persia, and part of Indostan. Neither was he able, though a brave and warlike prince, to extend his dominions, though he transmitted them to his son Ulug Beg. He proved a wife and learned monarch; and is famous for the astronomical tables which he caused to be composed, and which are well known at this day. He was killed in 1448 by his son Abdollatif, who six months after was put to death by his own soldiers. After the death of Abdollatif, Abdollah, a grandson of Shah Rukh, seized the throne; but, after reigning one year, was expelled by Abufaid Mirza, the grandson of Miran Shah the son of Timur. His reign was one conti-

nued scene of wars and tumults; till at last he was defeated and taken prisoner by one Hassan Beg, who put him to death in 1468. From this time we may look upon the empire of Timur as entirely dissolved, though his descendants still reigned in Persia and Indostan. The history of the latter, which is still known by the name of the *Mogul's empire*, we shall now give from the death of Abufaid Mirza to the present time.

On the death of the above-mentioned monarch, his son Babr, or Babor, succeeded him, but was soon driven out by the Usbeck Tartars; after which he resided some time in Gazna, whence he made incursions into Indostan, and at length became master of the whole empire, excepting the kingdoms of Dekan, Guzerat, and Bengal. He died in 1530, and was succeeded by his son Hemayun; who in the beginning of his reign conquered the province of Guzerat, excepting a very few places, and in 1540 made himself master of Bengal also; but soon after he was driven out of his dominions by the Afghans, a people inhabiting the mountainous country between India and Persia. In this distress he fled to the court of Persia; and being assisted by that monarch, recovered his kingdom; but three months afterwards was killed by an accidental fall in the year 1556, the 26<sup>th</sup> of his reign.

Hemayun was succeeded by his son Akbar, at that time only 13 years of age. He subdued Guzerat, Bengal, and Kabul, (a country lying beyond the limits of India Proper), and conquered several other countries; but proved unsuccessful in his attempts on Dekan. He poisoned himself by mistake in 1605, having swallowed the dose he had caused to be prepared for one of his principal lords; and was succeeded by his son Jehan Ghir. The reign of this prince was full of troubles, owing chiefly to his own misconduct. He invaded Dekan without success, and was four years a prisoner in the hands of one of his generals named *Mohabab Khan*; from whom, however, he at last found means to escape, and enjoyed his empire till the year 1627, when he died, and was succeeded by his son Shah Jehan.

The new emperor proved a very debauched and avaricious prince; which gave occasion to one of his sons named *Aureng-zib*, or *Aureng-zebe*, to dethrone him. This prince attained his end by a train of deep hypocrisy and dissimulation; covering his ambition with a pretence of religion, and under that pretence committing the greatest crimes. He defeated two of his brothers who opposed him, by unforeseen accidents, when he himself seemed to be on the very brink of destruction; and when he attained sufficient power, put them to death, and then lamented their misfortune. One of his brothers who assisted him, he rewarded with perpetual imprisonment, and at last put him to death also. The history of the empire, after he began to reign, is very much unknown, because Aurengzebe would not allow it to be written during his life. Neither do we meet with any thing of importance regarding this empire till the invasion of Thomas Kouli Khan, or Nadir Shah, emperor of Persia, which happened in 1739.

This conqueror did not invade India, as Jenghiz Khan and Tamerlane had done, with a view to plunder; though, after he became master of Delhi, he

23  
Bajazet de-  
feated and  
taken pri-  
soner.

22  
History of  
Indostan.

21  
Death of  
Tamerlane,  
and dissolu-  
tion of his  
empire.

23  
The empire  
invaded by  
Nadir Shah.

Mogul. seems not to have been inferior in rapacity to any of his predecessors. He was invited, however, by some of the great men who were disaffected to the emperor Nafroddin Mohammed Shah, in order to settle the affairs of the empire. Nadir was easily induced to accept the invitation, and set out from Kandahar with an army of 125,000 men, composed of many different nations, and, being all inured to hardships, were, much more than sufficient to have conquered the whole force of the effeminate Indians. Accordingly he defeated the forces sent against him; after which he was visited by the Mogul himself. Him he severely reprimanded for his misconduct. However, he told him, that as he was of the race of Timur, who had not offended the reigning family of Persia, he would not take the empire from him; only as he had put him to the trouble of coming so far to settle his affairs, he insisted that his expences should be paid. To this speech the Mogul made no answer; however, Nadir Shah took care to enforce the latter part of it. Some days after the Mogul's return, the Persian monarch went to his camp to pay him a visit, where he seized 200 cannon, with some treasure and other effects, sending them off immediately to Kandahar. He then marched to Dehli, where a dreadful slaughter was made, owing to a mob which arose about the price of corn. Nadir Shah, endeavouring to quell it, narrowly escaped being killed by a musket-ball shot purposely at him; which enraged him to such a degree, that he gave orders for an indiscriminate massacre. These orders were obeyed with the utmost alacrity by his soldiers; and 120,000, some say 150,000, of the inhabitants perished at once. After this all the jewels, gold-plate, &c. which could be found were seized, and the Shah demanded a present of money amounting to about 25 millions sterling; which was raised with such rigour, that many chose to put an end to their own lives rather than bear the torments which were inflicted on those who could not pay the sum at which they were assessed. At last, however, the sum was made up; and Nadir Shah took leave of the Mogul, with all the marks of friendship. He put the crown on his head with his own hands; and after having given him some good advice concerning the regulation and government of the empire, set out from Dehli on the 6th of May 1739.

By this invasion the empire sustained a prodigious loss. Since the arrival of Shah Nadir in the country, about 200,000 people had been destroyed, and the conquerors had carried off treasure and goods to the amount of 125 millions Sterling. Nevertheless even this dreadful calamity did not awaken the sufferers to a sense of their danger, nor was any step taken to put the empire in a proper state of defence; so that it still continues a prey to every invader, and equally incapable of subduing its enemies, or of defending itself.

Hindoostan, or the empire of the Great Mogul, or Mogul, is bounded on the north by Great and Little Tibet; on the east by Tibet, and the Farther Peninsula of the Indies; on the south by the Hither Peninsula, part of the Indian Sea, and Bay of Bengal; and on the west by Persia. It is situated between the 84th and 102d degrees of longitude, and between the 21st and 36th degrees of latitude; being in length about

1204 miles, and in breadth 960, though in some parts not near so much.

Towards the north, Hindoostan is very cold and barren; but towards the south, very hot, and fertile in corn, rice, fruits, and other vegetables. The northern provinces are very mountainous and sandy; while the southern are for the most part level, and well watered with several rivers.

The most remarkable mountains are those which surround it on three sides. Those on the west, separating it from Persia, called, in general, *Soleyman Khy*, or the mountains of *Soleyman*, are of a vast height as well as breadth, and are only passable in certain places, through which roads have been made for the sake of commerce. The chief are those which lead to Kabul, Gazna, and Kandahar. This great chain of mountains is inhabited by different nations, the principal of which are the Afghans, or Patans, and the Baluches, who have extended themselves on the side of India, as well as Persia. The mountains on the north are called *Nagrakut*, *Hima*, or *Mts Tag*, which has an affinity with *Imaüs*, and by other names, which are given also in common to the mountains on each side, separating Hindoostan from Tibet. The very prospect of these mountains is frightful, being nothing but hideous precipices, perpetually covered with snow, and not to be crossed without the greatest danger and difficulty.

The most remarkable rivers of Hindoostan are the Indus and Ganges. The former is called by the orientals *Send*, *Sind*, or *Sindi*. It rises in the mountains to the north, or north-east, of Hindoostan; whence, after a long course, first to the south and then to the south-west, it falls into the Persian sea, below Lower Bander, by several mouths. In its course it receives several other large rivers, as the Nilah, Jamal, Behat, and Lakka.

The Ganges, called in the Indies *Ganga*, rises in the kingdom of Tibet; entering Hindoostan, about the 30th degree of latitude, it runs first south-eastward by the cities of Bekäner, Minapor, Halabas, Benäres, and Patna, to Rajah Mahi, where it divides into two branches. The eastern having passed by Däkka, the capital of Bengal, enters the gulph of that name about Chatigan. The western, descending by Koffum-Bazar and Hughley, falls into the gulph below Shandernagor, towards Pipeli.

Many of the Jews and ancient Christians believed this river to be the Pison, one of the four mentioned in scripture as the boundaries of the terrestrial paradise. The Indians retain the greatest reverence for its waters, going in crowds from the remotest parts of the country to wash in them, from a persuasion that they deface from all the spots of sin. The reason of this is, because they imagine this river does not take its source from the bosom of the earth, but descends from heaven into the Paradise of Dewendre, and from thence into Hindoostan. Nothing is more childish than the fables of the Bramins on this subject, yet the people swallow them all. The Mogul and prince of Golconda drink no other water than that of the Ganges: foreigners, on the contrary, pretend that it is very unwholesome, and that it cannot be safely drunk till it is first boiled. There are a great number of superb pagodas on the banks of the Ganges, which are im-

24  
Inhabitants  
of Dehli  
slaughtered.

25  
Description  
of Hindoo-  
stan.

Mogul. immensely rich. At certain festivals, there has been sometimes a concourse of 100,000 people who came to bathe in it. But what principally distinguishes this river, besides its greatness and rapidity, is the gold it brings down in its sands, and throws on its banks; and the precious stones and pearls it produces, not only in itself, but in the Gulph of Bengal, into which it discharges its waters, and which abound therewith. The Chun, or Jemma, the Guderatu, the Perfilis, Lokia, and several other rivers, discharge themselves into it during its course.

The weather and seasons are, for the general, very regular in this spacious country; the winds blowing constantly, for six months, from the south, and six from the north, with very little variation. The months of April, May, and the beginning of June, till the rains fall, are so extremely hot, that the reflexion from the ground is apt to blister one's face; and, but for the breeze, or small gale of wind, which blows every day, there would be no living in that country for people bred in northern climates; for, excepting in the rainy season, the coldest day is hotter there at noon than the hottest day in England. However, very surprising changes of heat and cold sometimes happen within a few hours; so that a stifling hot day is succeeded by a night cold enough to produce a thin ice on the water, and that night by a noon as scorching as the preceding. Sometimes, in the dry season, before the rains, the winds blow with such extreme violence, that they carry vast quantities of dust and sand into the air, which appear black, like clouds charged with rain; but fall down in dry showers, filling the eyes, ears, and nostrils of those among whom they descend, and penetrate every chest, cabinet, or cupboard, in the houses or tents, by the key-hole or crevices.

From Surat to Agra, and beyond, it seldom or never rains, excepting in one season of the year; that is, from the middle of June to the middle of September. These rains generally begin and end with most furious storms of thunder and lightning. During these three months it rains usually every day, and sometimes for a week together without intermission; by this means the land is enriched, like Egypt by the Nile. Although the land looks before like the barren sands of the Arabian deserts; yet, in a few days after those showers begin to fall, the surface appears covered with verdure. When the rainy season is over, the sky becomes perfectly serene again, and scarce one cloud appears all the nine months; however, a refreshing dew falls every night, during that dry interval, which cools the air, and cherishes the earth.

The produce of Hindostan is very rich in every kind, whether it be fossil, vegetable, or animal. Besides other precious stones found in it, there is a diamond-mine at the town of Soumelpour, in Bengal. Quarries of Theban stone are so plentiful in the Mogul's empire, that there are both mosques and pagods built entirely of it. Some travellers tell us, there are mines of lead, iron, and copper, and even silver; but those of the last, if there be any, need not be opened, since the bullion of all nations is sunk in this empire, which will take nothing else in exchange for her commodities, and prohibits the exporting it again. They till the ground with oxen and foot-ploughs, sowing in

May and the beginning of June, that all may be over before the rains, and reaping in November and December, which with them is the most temperate month in the year. The land is no where enclosed, excepting a little near towns and villages. The grafs is never mowed to make hay, but cut off the ground, either green or withered, as they have occasion to use it. Wheat, rice, barley, and other grain, grow here in plenty, and are very good. The country abounds no less in fruits, as pomegranates, citrons, dates, grapes, almonds, and cocoa-nuts; plums, those especially called *mirabolans*; plantanes, which in shape resemble a slender cucumber, and in taste excel a Norwich pear; mangos, an excellent fruit, resembling an apricot, but larger; ananas, or pine-apples; lemons and oranges, but not so good as in other countries; variety of pears and apples in the northern parts; and the tamarind-tree, the fruit of which is contained in a pod resembling those of beans. There are many other kinds of fruit trees peculiar to the country. But the valuable trees are the cotton and mulberry, on account of the wealth they bring the natives from the manufactures of callicoes and silks. They plant abundance of sugar-canes here, as well as tobacco; but the latter is not so rich and strong as that of America, for want of knowing how to cure and order it.

Hindostan affords also plenty of ginger, together with carrots, potatoes, onions, garlic, and other roots known to us, besides small roots and herbs for salads; but their flowers, though beautiful to look at, have no scent, excepting roses, and some few other kinds.

There is a great variety of animals in this country, both wild and tame; of the former are elephants, rhinoceroses, lions, tygers, leopards, wolves, jackals, and the like. The jackals dig up and eat dead bodies, and make a hideous noise in the night. The rhinoceros is not common in the Mogul's empire; but elephants are very numerous, some 12, 14, or 15 feet high. There is plenty of venison, and game of several kinds; as red-deer, fallow-deer, elks, antelopes, kids, hares, and such like. None of these are imparked, but all in common, and may be any body's who will be at the pains to take them. Among the wild animals also may be reckoned the musk-animal, apes, and monkeys.

Hindostan affords variety of beasts for carriage, as camels, dromedaries, mules, asses, horses, oxen, and buffaloes. Most of the horses are white, and many curiously dappled, pied, and spotted all over. The flesh of the oxen is very sweet and tender. Being very tame, many use them as they do horses, to ride on. Instead of a bit, they put one or two small strings through the grille of the nostrils, and fastening the ends to a rope, use it instead of a bridle, which is held up by a bunch of gristy flesh which he has on the forepart of his back. They saddle him as they do a horse; and, if spurred a little, he will go as fast. These are generally made use of all over the Indies; and with them only are drawn waggons, coaches, and chariots. Some of these oxen will travel 15 leagues in a day. They are of two sorts; one six feet high, which are rare; another called *dwarfs*, which are only three. In some places, where the roads are stony, they shoe their oxen, when they are to travel far. The buffalo's skin makes excellent:

Mogul. excellent buff, and the female yields very good milk; but their flesh is neither so palatable nor wholesome as beef. The sheep of Hindostan have large heavy tails, and their flesh is very good, but their wool coarse.

This country is much infested with reptiles and insects; some of a noxious kind, as scorpions, snakes, and rats; but the lizards, which are of a green colour, are not hurtful. Snakes and serpents, we are told, are sometimes employed to dispatch criminals, especially such as have been guilty of some atrocious crime, that kind of death being attended with the most grievous torture. The most troublesome insects in this hot country are flies, musktoes, and chinchies, or bugs, the first by day, and the others in the night, when they offend no less by their stench than their bite.

26  
Account of  
the inhabi-  
tants.

Hindostan is inhabited by several different kinds of people, as the Hindoos, the Patans or Afghans, the Baluchis, the Parsis, and the Moguls or Tartars, besides foreigners, especially Jews and Christians of various sects. The Hindoos are the ancient inhabitants; and though subject to the Moguls, are at least some hundreds to one, compared with all the rest. The Parsis are the descendants of the ancient Persians, who worshipped the fire. These fled from India to avoid the persecution of the Mahometans; and are settled on the western peninsula, chiefly about Surat. The Patans, or Afghans, for they seem to be the same people under different names, are those from whom the Moguls conquered Hindostan. They are still very numerous; chiefly in the mountains and north-west parts, towards Kabul, Gazna, and Kandahar, from whence in all probability they originally came. They are a fierce and warlike people, and have a great aversion to the Moguls for having dispossessed them of their territories. The Baluchis, a barbarous people, and much given to rapine, possess several parts of Hindostan to the west of the Indus, particularly the province of Hajakhan. Both they and the Afghans also possess several parts of Persia. The Moguls, or Jagatays, are the present lords of Hindostan, where they reign over the rest, for the most part, with an absolute sway. Of these several nations, the Hindoos and Parsis are Pagan; but excel all the rest in modest deportment and the practice of virtue. The Patans, Baluchis, and Moguls, are Mahometans; and the first and last pretty strict observers of the laws and the rules of justice, at least among themselves. It is rare to see a crooked or deformed person, an idiot, or natural fool, in Hindostan. As to the complexion of the natives, they are of a deep tawny or olive colour; their hair jet black, but not curled. They like not people who are very white or fair, because that is the colour of lepers, who are common in those parts. Most of the Mahometans, except their priests and ancient men, keep their chins constantly shaven, but let the hair on their upper lip grow very long. They shave their heads all over, leaving only a lock on the crown, by which they expect to be drawn up to heaven by their prophet Mahomet. Instead of hats or bonnets, they wear a kind of turban, consisting of a piece of narrow calico, wound several times about the head. The inhabitants, in general, are very civil and courteous, as well to strangers as one another. They salute by bowing the head or their body, laying the right hand on their breast, and uttering compliments as they pass. The meaner people

Mogul. salute their superiors in a very submissive manner, either by putting the right hand to the ground, and then laying it on their head; or else by falling on their knees, and then bowing their head to the earth. In their more familiar salutations, they take each other by the chin, or beard, and cry *Baba*, "father," or *Bij*, "brother." The dress of the inhabitants of Hindostan is all the same in great and small, rich and poor, differing only in cost; for they never alter their fashions. Their upper-coats, to the waist, fit close to their bodies, whence they hang loose a little below their knees. Under this out-coat, they usually wear another slight one of the same cloth, but shorter, in the nature of a vest. Some of the richer sort, in the cooler parts of the day, slip on loose coats over the other, made of quilted silk, or calico, or else of English scarlet-cloth, for that is the colour they most affect. Under their coats they wear a sort of trowsers, which fall down to their ancles, and ruffle on the small of their legs; for their feet are always bare in their shoes, but as clean as their hands. They have girdles, made of a long piece of cloth, which go twice at least about them, the ends hanging down.

The dress of the Mahometan women differs but little from that of the men; only they bind their hair with long fillets, which hang down behind, and wear on their heads mantles or veils of calico; all round their ears they wear small pendants, made of thin and narrow pieces of gold or silver, brass or iron, according to the quality of the person. The lower part of their left nostril is also pierced for putting in rings of those metals at pleasure; the ends of their gold rings meet in a pearl, drilled for that purpose. Some of the better sort wear great hollow rings of gold enamelled, silver, or brass, upon their wrists and the small of their legs, two or three on each limb, which makes a tinkling noise when they move.

Although the Mahometans are allowed four wives, very few, and those only of the richer sort, take more than one. They are so jealous, that they will not suffer either father or brother to speak to their wives, unless in their presence. Adultery and fornication are reckoned in the highest degree criminal. Great men have eunuchs to guard their women. Common prostitutes are tolerated here; but they must be licensed, before they are at liberty to open a house.

The women are exceeding happy in this part of the world in having easy labours; for it is common to see them one day riding big with child, and the next day riding again with the infants in their arms. The children of the poorer sort go naked several years, only now and then their mothers cover them with a slight calico mantle.

The Mahometans bury not in their mosques or churches, but in some open place out of town.

Their mourning over the deceased is immoderate, especially at their graves; when they often ask the party, as if living, Why he would die, since he had such loving wives and friends, and other comforts, in this life? The men of the greatest quality often provide fair sepulchres for themselves and friends. There are also many handsome monuments erected in memory of such as they esteem pious, or saints; which are much resorted to by devout people, having lamps continually burning in them, with votaries, who have salaries to attend

Mohair attend them. The Mahometans bestow not so much cost on any sort of fractures as on sepulchres.

Moldavia.

The common language of the empire, called the *Hind-djishan*, has a great affinity with the Persian and Arabic, but is more smooth, and very significant and concise. Its characters are different from those of the above languages, and written from the left hand to the right, like the European. All the learning of the Moguls consists in reading and writing; however, the people themselves are men of very strong reason, and will speak off-hand on any subject exceeding well. Their chief study is astrology, with the belief of which the generality are strangely infatuated; the Great Mogul himself undertaking nothing of any moment without consulting his astrologers. For an account of the different religions in this empire, see the articles MAHOMETANISM and GENTOO; and HINDOO in the APPENDIX.

MOHAIR, in commerce, the hair of a kind of goat frequent about Angria in Turkey; the inhabitants of which city are all employed in the manufacture of camlets made of this hair.

MOHAWK COUNTRY, a part of North America, inhabited by one of the five nations of the Iroquois, situated between the province of New York and the lake Ontario or Frontignac.

MOHILA, or MOELIA, one of the Comorra islands in the Indian sea, between the north end of the island of Madagascar and the continent of Africa. The inland parts are mountainous and woody; but the lands adjoining to the sea are watered by several fine streams which descend from the mountains; and the grass is green all the year, so that it affords a most delightful habitation. There are plenty of provisions of all kinds; and the East India ships of different nations sometimes touch here for refreshment.

MOHILOF, a large and strong city of Poland, in the province of Lithuania, and palatinate of Mieslan. It is well built, populous, and has a considerable trade. Near this place the Swedes obtained a great victory over the Russians in 1707.

MOLDORE, a Portuguese gold coin, value 11. 7s. Sterling.

MOIETY, the half of any thing.

MOLA, an ancient town of Italy, in the kingdom of Naples, and in the Terra di Lavoro, where they pretend to shew the ruins of Cicero's house. It is seated on the gulf of Venice, in E. Long. 17. 50. N. Lat. 41. 5.

MOLARES, or DENTES MOLARES, in anatomy, the large teeth, called in English the *grinders*. See ANATOMY, n<sup>o</sup> 26, l.

MOLDAVIA, a province of Turkey in Europe, bounded on the north-east by the river Neister, which divides it from Poland; on the east, by Bessarabia; on the south by the Danube, which parts it from Bulgaria; and on the west, by Walachia and Transylvania; it being 240 miles in length, and 150 in breadth. It lies in a good air and fruitful soil, producing corn, wine, rich pastures, a good breed of horses, oxen, sheep, plenty of game, fish, fowl, honey, wax, and all European fruits. Its principal rivers are the Danube, Neister, Pruth, Bardalach, and Ceret. The inhabitants are Christians of the Greek church, and Jassy is the principal town. It has been tributary to the Turks

ever since the year 1574; who appoint a prince who is a native of the country, but have no regard to his being of the principal families. They pay a large yearly tribute; besides which, they are obliged to raise a great body of horse at their own expence.

MOLE, a river in Surry, which has taken its name from running under ground. It first disappears at Box-hill, near Darking, in the county of Surry, and emerges again near Leatherhead.

MOLE, in zoology. See TALPA.

Moles in the fields may be destroyed by taking a head or two of garlic, onion, or leek, and putting it into their holes; or on which they will run out as if frightened, and you may kill them with a spear or dog. Or pounded hellebore, white or black, with wheat-flour, the white of an egg, milk, and sweet-wine, or metheglin, may be made into a paste, and pellets as big as a small nut may be put into their holes: the moles will eat this with pleasure, and will be killed by it. In places where you would not dig nor break much, the fuming their holes with brimstone, garlic, or other unfavoury things, drives them away; and if you put a dead mole into a common haunt, it will make them absolutely forsake it.

Or take a mole-spear or staff, and where you see them cast, go lightly; but not on the side betwixt them and the wind, lest they perceive you; and at the first or second putting up of the earth, strike them with your mole-staff downright, and mark which way the earth falls most: if the casts towards the left-hand, strike somewhat on the right-hand; and so on the contrary, to the casting up of the plain ground, strike down, and there let it remain; then take out the tongue in the staff, and with the spatule, or flat edge, dig round about your grain to the end thereof, to see if you have killed her; and if you have missed her, leave open the hole, and step aside a little, and perhaps she will come to stop the hole again, for they love but very little air; and then strike her again; but if you miss her, pour into the hole two gallons of water, and that will make her to come out for fear of drowning: mind them going out of a morning to feed, or coming home when fed, and you may take a great many.

MOLE, in midwifery, a mass of fleshy matter, of a spherical figure, generated in the uterus, and sometimes mistaken for a child. See MIDWIFERY, chap. ii.

MOLE, or *Mark*. See NEVUS.

MOLE is also a massive work of large stones laid in the sea by means of coffer-dams; extending before a port, either to defend the harbour from the impetuosity of the waves, or to prevent the passage of ships without leave.

MOLE-Cricket. See GRYLLOTALPA.

MOLESWORTH (Robert), Viscount Moleworth, an eminent statesman and polite writer, born at Dublin in 1656, where his father was a merchant. He was appointed by king James for his activity on the prince of Orange's invasion; but the latter, when he was settled on the throne, called up Mr Moleworth into the privy-council, and sent him envoy-extraordinary to the court of Denmark. Here he resided above three years, and then returned upon some disgust, without an audience of leave. Upon his return, he drew up his Account of Denmark, a work well known, in which

Mole  
Moleworth

Moliere,  
Molinos.

which he represented that government as arbitrary; and hence gave great offence to George prince of Denmark. The Danish envoy presented a memorial to king William concerning it; and then furnished materials for an answer, which was executed by Dr Moleworth King. Mr Moleworth was member of the houses of commons in both kingdoms: king George I. made him a commissioner of trade and plantations, and advanced him to the peerage of Ireland, by the title of *Baron Philipstown*, and *Viscount Moleworth of Swords*. He died in 1725. Beside his Account of Denmark, he wrote an address to the house of commons, for the encouragement of agriculture; and translated Franco Gallia, a Latin treatise of the civilian Hottoman, giving an account of the free state of France, and other parts of Europe, before the encroachments made on their liberties.

MOLIERE (John Baptist), a famous French comedian, whose true name was *Pocquelin*, which for some reason or other he sunk for that of Moliere. He was the son of a valet de chambre, and was born at Paris about the year 1620. He went through the study of the classics under the Jesuits in the college of Clermont, and was designed for the bar; but as his quitting the law-schools, he made choice of the actor's profession. From the prodigious fondness he had for the drama, his whole study and application being directed to the stage, he continued till his death to exhibit plays, which were greatly applauded. It is said the first motive of his going upon the stage was to enjoy the company of an actress, for whom he had contracted a violent fondness. His comedies are highly esteemed. And it is no wonder he so justly represented domestic feuds, and the torments of jealous husbands, or of those who have reason to be so, it being asserted that no man ever experienced all this more than Moliere, who was very unhappy in his wife. His last comedy was *La Malade imaginaire*, which was brought on the stage in 1673; and Moliere died on the fourth night of its representation; some say in acting the very part of the pretended dead man, which gave some exercise for the wits of the time; but according to others, he died in his bed that night, from the bursting of a vein in his lungs by coughing. The king, as a last mark of his favour, prevailed with the archbishop of Paris to suffer him to be buried in consecrated ground; though he had irritated the clergy by his *Tartuffe*. The most esteemed editions of his works are that of Amsterdam, 5 vols 12mo, 1699; and that of Paris, 6 vols 4to, 1734.

MOLINOS (Michael), a Spanish priest, who endeavoured to spread new doctrines in Italy. He was born in the diocese of Saragossa in 1627; and entered into priest's orders, though he never held any ecclesiastical benefice. He was a man of good sense and learning, and his life was exemplary; though, instead of practising austerities, he gave himself up to contemplation and mystical devotion. He wrote a book intitled, *Il Guida Spirituale*, containing his peculiar notions, which was greedily read both in Italy and Spain. His followers are called *Quietists*; because his chief principle was, that men ought to annihilate themselves in order to be united to God, and afterwards remain in quietness of mind, without being troubled for what shall happen to the body. He was taken up in 1687;

and his 68 propositions were examined by the pope and inquisitors, who decreed that his doctrine was false and pernicious, and that his books should be burned. He was forced to recant his errors publicly in the Dominicans church, and was condemned to perpetual imprisonment. He was 50 years old when he was taken, and had been spreading his doctrine 22 years before. He died in prison in 1692.

MOLOCH, a false god of the Ammonites, who dedicated their children to him, by making them "pass through the fire," as the scriptures express it. There are various opinions concerning this method of consecration. Some think, the children leaped over a fire sacred to Moloch; others, that they passed between two fires; and others, that they were really burnt in the fire, by way of sacrifice to this god. There is foundation for each of these opinions. For, first, it was usual among the pagans to lustrate or purify with fire; and, in the next place, it is expressly said, that the inhabitants of Sepharvaim burnt their children in the fire to Anamlech and Atrammelech; much such deities as Moloch of the Ammonites.

Moses, in several places, forbids the Israelites to dedicate their children to this god, as the Ammonites did, and threatens death and utter extirpation to such persons as were guilty of this abominable idolatry. And there is great probability that the Hebrews were much addicted to the worship of this deity; since Amos, and after him St Stephen, reproaches them with having carried along with them into the wilderness the tabernacle of their god Moloch.

Solomon built a temple to Moloch upon the mount of Olives; and Manasseh, a long time after, imitated his impiety, by making his son pass through the fire in honour of Moloch. It was chiefly in the valley of Tophet and Hinnot, to the east of Jerusalem, that the Israelites paid their idolatrous worship to this false god of the Ammonites.

There are various sentiments concerning the relation which Moloch had to the other pagan divinities. Some believe he was the same with Saturn, to whom it is well known that human sacrifices were offered. Others suppose him to be Mercury; others, Mars; others, Mithras; and others, Venus. Lastly, others take Moloch to be the sun, or the king of heaven. Moloch was likewise called *Milkom*; as appears from what is said of Solomon, that he went after Astartoth the abomination of the Zidonians, and Milkom the abomination of the Ammonites.

MOLOSSES, in commerce, the thick fluid matter remaining after sugar is made, like syrup. In Holland molasses are much used in the manufacture of tobacco, and by the poor people for sugar. A brandy is also distilled from them, but it is said to be unwholesome.

MOLOSSUS, in Greek and Latin poetry, a foot composed of three long syllables; as *delectant*.

MOLTEN-GREASE, in farrery. See there § xviii.  
MOLUCCA ISLANDS, lie in the East Indian sea under the line; of which there are five principal, namely, Ternate, Tydor, Machian, Motyr, and Bacchian. The largest of them are hardly 30 miles in circumference. They produce neither corn, rice, nor cattle, except goats: but they have oranges, lemons, and other fruits; and are most remarkable for spices, especially

Moloch  
Molucca.

Molwitz cially cloves. They have large snakes, which are not venomous, and very dangerous land crocodiles. At present they have three kings; and the Dutch, who are very strong there, keep out all other European nations, being jealous of their spice-trade. The religion is idolatry; but there are many Mahometans. They were discovered by the Portuguese in 1511, who settled upon the coast; but the Dutch drove them away, and are now masters of all these islands.

MOLWITZ, a town of Silesia, in the province of Grotzka, remarkable for a battle gained by the Prussians over the Austrians in 1741. E. Long. 16. 45. N. Lat. 50. 26.

MOLYBDIA, in natural history, the name of a genus of crystals of a cubic form, or composed of six sides, at right angles, like a dye.

MOLYNEUX (William), an excellent mathematician and astronomer, was born at Dublin in 1656, and admitted into the university of that city; which when he left, he carried with him, a testimonial drawn up in an uncommon form, and in the strongest terms, signifying the high opinion conceived of his genius, the probity of his manners, and the remarkable progress he had made in letters. In 1675, he entered in the middle-temple, where he spent three years in the study of the laws of his country: but the bent of his genius lay strongly toward mathematics and philosophical studies; and even at the university he conceived a dislike to scholastic learning, and fell into the methods of Lord Bacon. In 1683, he formed a society in Dublin, for carrying on the same design with the royal society in London. He soon got a few ingenious men to meet at stated times under proper regulations. Their number immediately increased; Sir William Petty was their first president, and Mr Molyneux their first secretary. Their society continued to meet till 1688, when the confusion of the times dispersed them. Mr Molyneux's reputation for learning recommended him, in 1684, to the notice and favour of the first and great duke of Ormond, then lord-lieutenant of Ireland; and chiefly by his grace's influence he was appointed, that year, with Sir William Robinson, surveyor-general of his majesty's buildings and works, and chief engineer. In 1686, he was sent abroad by the government to view the most considerable fortresses in Flanders. He travelled, in company with Lord Mountjoy, through that country, Holland, part of Germany, and France. Upon his return from Paris to London, in April 1680, he published his *Sciothericum Telescopium*, containing a description of the structure and use of a telescopic dial invented by him. The ferocities of Tyrconnel's government forced him, with many others, into England, where he spent two years with his family. In this retirement he wrote his *Dioptrics*, dedicated to the royal society. A parliament being called in Ireland under Lord Sidney in 1692, Mr Molyneux sat in it as one of the representatives of the university of Dublin. Upon the clove of the session, the university honoured him with the degree of doctor of laws; and by the lord-lieutenant he was appointed one of the commissioners for the forfeitures in Ireland, with a salary of 500*l.* per annum. The last favour he entirely declined, as engaging him in an invidious war. Not long before he died, he published "The Case of Ireland stated, in relation to its being bound by Acts

of Parliament made in England." Among many persons with whom he maintained correspondence and friendship, Mr Locke was in a particular manner dear to him, as appears from their letters. In 1698, he made a journey to England on purpose to pay a visit to that great man; and not long after his return to Ireland was seized with a fit of the stone, and died in 1698.—His son, Samuel Molyneux Esq; was born in 1689, and became secretary to George II. while prince of Wales, and one of the lords of the admiralty; in which place he died. He was a gentleman of great learning, especially in mathematical and philosophical subjects.

MOMBAZA, or MONBAZA, a town of Africa, in an island of the same name, with a castle and a fort; seated on the eastern coast, opposite to the country of Mombaza in Zanguebar, 70 miles south of Melinda, and subject to Portugal. E. Long. 48. o. N. Lat. 44. o.

MOMBAZA, a country of Africa, in Zanguebar, subject to the Portuguese, from whence they export slaves, gold, ivory, rice, flesh, and other provisions, with which they supply the settlements in Brasil. The king of this country being a Christian, had a quarrel with the Portuguese governor, took the cattle by assault, turned Mahometan, and murdered all the Christians in 1631; but in 1729 they became masters of the territory again.

MOMENT, in the doctrine of time, an instant, or the most minute and indivisible part of duration.

MOMENTUM, in mechanics, signifies the same with impetus, or the quantity of motion in a moving body; which is always equal to the quantity of matter multiplied into the velocity; or, which is the same thing, it may be considered as a rectangle under the quantity of matter and velocity.

MOMORDICA, MALE BALSAM APPLE; a genus of the syngenesia order, belonging to the monoclea class of plants. The most remarkable species are, 1. The balsamina, or male balsam apple. This is a native of Asia; and hath a trailing stalk like those of the cucumber or melon, with smooth leaves, cut into several segments, and spread open like a hand. The fruit is oval, ending in acute points, having several deep angles, with sharp tubercles placed on their edges. It changes to a red or purplish colour when ripe, opening with an elasticity, and throwing out its seeds. 2. The elaterium, wild or spurting cucumber, hath a large fleshy root, somewhat like briony, from whence come forth every spring several thick, rough, trailing stalks, dividing into many branches, and extending every way two or three feet; these are garnished with thick, rough, smooth heart-shaped leaves, of a grey colour, standing upon long foot-stalks. The flowers come out from the wings of the stalks: these are male and female, growing at different places on the same plant like those of the common cucumber; but they are much less, of a pale yellow colour, with a greenish bottom; the male flowers stand upon thick, short, foot-stalks, but the female flowers sit upon the young fruit; which, after the flower is faded, grows of an oval form, an inch and a half long, swelling like a cucumber, of a grey colour like the leaves, and covered over with short prickles. This species has one of its names from the property of casting out its seeds, together

Mombaza  
||  
Mormordica

MOMUS  
a  
Moriaco.

gether with the viscid juice in which the seeds are lodged, with a violent force, if touched while ripe.

*Ufer.* The first species is famous in Syria for curing wounds: the natives cut open the unripe fruit, and infuse it in sweet oil, which they expose to the sun for some days until it becomes red; and then present it for a use. Dropped on cotton, and applied to a fresh wound, the Syrians reckon this oil the best vulnerary next to balsam of Mecca, having found by experience that it often cures large wounds in three days. The leaves and stems of this plant are used for arbores or bows. The elaterium of the shops is the fruit, or rather the inspissated fecula, of the juice of the unripe fruit of the wild cucumber. It is usually sent us from Spain and the southern parts of France, where the plant is common. We receive it in small, flat, whitish lumps, or cakes, that are dry, and break easily between the fingers. It is of an acrid, nauseous, bitter taste, and has a strong offensive smell when newly made; but these, as well as its other properties, it loses after being kept for some time. It is a very violent purge and vomit, and is now but seldom used. From the property which the plant has of throwing out its seeds, it has sometimes been called *Noli me tangere*.

MOMUS, in fabulous history, the god of raillery, or the jester of the celestial assembly, and who ridiculed both gods and men. Being chosen by Vulcan, Neptune, and Minerva, to give his judgment concerning their works, he blamed them all: Neptune for not making his bull with horns before his eyes, in order that he might give a surer blow; Minerva for building an house that could not be removed in case of bad neighbours; and Vulcan, for making a man without a window in his breast, that his treacheries might be seen.

MONA, two islands of this name in the sea lying between Britain and Ireland. The one described by Cæsar, as situated in the mid-passage between both islands, and stretching out in length from south to north. Called *Monaxda*, (Ptolemy); *Monapia*, or *Monabia*, (Pliny). Supposed to be the Isle of Man. Another Mona, (Tacitus), an island more to the south, and of greater breadth; situate on the coast of the Ordoices, from whom it is separated by a narrow strait. The ancient seat of the Druids. Now called *Anglesey*, the island of the Angles or English.

MONA, an island of the Baltic-Sea, south-west of the island of Zealand, subject to Denmark. E. Long. 12. 30. N. Lat. 55. 20.

MONADELPHIA, (from *μονα* "alone," and *ἀδελφία* a "brotherhood,") a single brotherhood; the name of the 16th class in Linnæus's sexual system, consisting of plants with hermaphrodite flowers; in which all the stamina, or male organs of generation, are united below into one body or cylinder, through which passes the pointal or female organ. See BOTANY, p. 1296.

MONACO, a small, but handsome and strong town of Italy, in the territory of Genoa, with a castle, citadel, and a good harbour. It is seated on a craggy rock; and has its own prince, under the protection of France. E. Long. 7. 33. N. Lat. 43. 48.

MONAGHAN, a county of Ireland, in the province of Ulster, 32 miles long and 22 broad. It is bounded on the north by Tyrone; on the east by Ar-

magh; on the south by Cavan and Louth; and on the west by Fermanagh. It is full of woods and bogs, and a third part of it is taken up by Lough Earne. It contains 24 parishes, five baronies, one borough, near 10,000 houses, and sends four members to parliament. Some time ago there were discovered on the borders of this county, four teeth of a prodigious magnitude, which the royal society, upon comparing with some teeth which had been found in England, were clearly of opinion could be no other than those of the elephant.

MONANDRIA, (from *μονα* "alone," and *ανδρ* a "man or husband;") the name of the first class in Linnæus's sexual system; consisting of plants with hermaphrodite flowers, which have only one stamen or male organ.

MONARCHY, a government in which the supreme power is vested in a single person. See GOVERNMENT.

MONARDA, INDIAN HOREHOUND; a genus of the monogynia order, belonging to the diandria class of plants. The most remarkable species is the zeylanica, a native of the East Indies. It rises with an herbaceous, four-cornered, hoary stalk; and bears leaves that are entire, nearly heart-shaped, woolly, deeply notched on the edges, and having foot-stalks. The flowers, which are purplish and fragrant, surround the stalk in whorls, each whorl containing about 14 flowers; and are succeeded by four small kidney-shaped shining seeds, lodged in the bottom of the permanent flower-cup. The Indians superstitiously believe that a fumigation of this plant is effectual for driving away the devil, and from this imaginary property its name in the Ceylonese language is derived. Grimmus relates, in his *Laboratorium Ceylonicum*, that for taste and smell this species of horehound stands remarkably distinguished. A water and subtle oil are obtained from it, both of which are greatly commended in obstructions of the matrix. A syrup is likewise prepared from this plant, which is useful in the above-mentioned disorders as well as in diseases of the stomach.

MONARDES (Nicholas), an excellent Spanish physician of Seville, who lived in the 16th century; and deservedly acquired great reputation by his practical skill and the books which he wrote. His Spanish works have been translated into Latin by Clusius; into Italian by Annibal Brigantus; and those upon American drugs have appeared in English. He died about the year 1578.

MONASTERY, a convent, or house built for the reception and entertainment of monks, mendicant friars, or nuns, whether it be an abbey, priory, &c.

Monasteries are governed by different rules, according to the different regulations prescribed by their founders. The first regular and perfect monasteries were founded by St Pachomius in Egypt: but St Basil is generally considered as the great father and patriarch of the eastern monks; since, in the fourth century, he prescribed rules for the government of the monasteries, to which the Anachorets and Cœnobites, and the other ancient fathers of the deserts, submitted. In like manner St Benedict was styled the patriarch of the western monks. He appeared in Italy towards the latter end of the fifth century, and published his rule, which was universally received throughout the west.

St

Monaghan  
6  
Monastery.



St Augustine being sent into England by St Gregory the pope, in the year 596, to convert the English, he at the same time introduced the monastic state into that kingdom; which made such progress there, that, within the space of 200 years, there were 30 kings and queens who preferred the religious habit to their crowns, and founded stately monasteries, where they ended their days in retirement.

**MONASTIC**, something belonging to monks. See **MONK**.

**MONCAON**, or **MONZON**, a town of Portugal, in the province of Entre-Douro-de-Minho, with a strong castle. The Spaniards have several times attempted to take it, but in vain. W. Long. 8. 2. N. Lat. 41. 52.

**MONCON**, or **MONZON**, a strong town of Spain, in the kingdom of Arragon. It was taken by the French in 1642, but the Spaniards retook it the following year. It is seated at the confluence of the rivers Sofa and Cinca. E. Long. 0. 19. N. Lat. 41. 43.

**MONDOVI**, a considerable town of Italy, in Piedmont; with a citadel, university, and bishop's see. It is the largest and most populous town of Piedmont, and is seated in E. Long. 8. 15. N. Lat. 44. 23.

**MONDAY**, the second day of the week, so called as being anciently sacred to the moon; *q. d.* moon-day.

**MONEMUGI**, an empire in the south of Africa, has Zanguebar on the east, Monotapa on the south, Motamba and Makoko on the west, and Abyssinia on the north and partly to the east, tho' its boundaries that way cannot be ascertained. It is divided into the kingdoms of Mujaco, Makoko or Anfiko, Gingiro, Cambate, Alaba, and Monemugi Proper. This last lies in the middle of the torrid zone, and about the equinoctial line south of Makoko, west of Zanguebar, north of Monotapa, and east of Congo and of the northern parts of Monotapa: To ascertain its extent, is too difficult a task, being a country so little frequented. The country known, abounds with gold, silver, copper mines, and elephants. The natives clothe themselves in silks and cottons, which they buy of strangers, and wear collars of transparent amber-beads, brought them from Cambaya: which beads serve also instead of money; gold and silver being too common, and of little value among them.

Their monarch always endeavours to be at peace with the princes round about him, and to keep an open trade with Quitoa, Melinda, and Mombaza, on the east, and with Congo on the west; from all which places the black merchants resort thither for gold. The Portuguese merchants report, that on the east side of Monemugi there is a great lake full of small islands, abounding with all sorts of fowl and cattle, and inhabited by negroes. They relate also, that on the main land eastward they heard sometimes the ringing of bells, and that one could observe buildings very much like churches; and that from these parts came men of a brown and tawny complexion, who traded with those islands, and with the people of Monemugi.

This country of Monemugi affords also abundance of palm-wine and oil, and such great plenty of honey, that above half of it is lost, the blacks not being able to consume it. The air is generally very unwholesome, and

excessively hot, which is the reason why no Christians undertake to travel in this empire. De Lisle gives the division of this country as follows: The Maracates, the Messiguaries, the kingdom of the Buengas, the kingdom of Malli, and that of Maravi. But we are not acquainted with any particulars relating to these nations or kingdoms.

**MONEY**, a piece of matter, commonly metal, to which public authority has affixed a certain value and weight to serve as a medium in commerce. See **COIN**, **COMMERCE**, and **MEDALS**.

Money is usually divided into *real* or *effective*, and *imaginary* or *money of account*.

**I.** Real money includes all coins, or species of gold, silver, copper, and the like; which have course in commerce, and do really exist. Such are guineas, pistoles, pieces of eight, ducats, &c.

Real money, civilians observe, has three essential qualities, viz. matter, form, and weight or value.

For the matter, copper is that thought to have been first coined; afterwards silver; and lastly gold, as being the most beautiful, scarce, cleanly, divisible, and pure of all metals.

The degrees of goodness are expressed in gold by carats; and in silver by penny-weights, &c. For there are several reasons for not coining them pure and without alloy, viz. the great loss and expence in refining them, the necessity of hardening them to make them more durable, and the scarcity of gold and silver in most countries. See **ALLOY**.

Among the ancient Britons, iron rings, or, as some say, iron plates, were used for money; among the Lacedaemonians, iron bars quenched with vinegar, that they might not serve for any other use. Seneca observes, that there was anciently stamped money of leather, *corium forma publica impressum*. And the same thing was put in practice by Frederic II. at the siege of Milan; to say nothing of an old tradition among ourselves, that in the confused times of the barons wars the like was done in England: but the Hollanders, we know, coined great quantities of paste-board in the year 1574.

As to the form of money, it has been more various than the matter. Under this are comprehended the weight, figure, impression, and value.

For the impression, the Jews, tho' they detested images, yet stamped on the one side of their shekel the golden pot which had the manna, and on the other Aaron's rod. The Dardans stamped two cocks fighting. The Athenians stamped their coins with an owl, or an ox; whence the proverb on bribed lawyers, *Bos in lingua*. They of Aegina, with a tortoise; whence that other saying, *Virtutem & sapientiam vincunt testudines*. Among the Romans, the monetarii sometimes impressed the images of men that had been eminent in their families on the coins: but no living man's head was ever stamped on a Roman coin till after the fall of the commonwealth. From that time they bore the emperor's head on one side. From this time the practice of stamping the prince's image on coins, has obtained among all civilized nations; the Turks and other Mahometans alone excepted, who, in detestation of images, inscribe only the prince's name, with the year of the transmigration of their prophet.

As to the figure, it is either round, as in Britain;

Money.

multangular or irregular, as in Spain; square, as in some parts of the Indies; or nearly globular, as in most of the rest.

After the arrival of the Romans in this island, the Britons imitated them, coining both gold and silver with the images of their kings stamped on them. When the Romans had subdued the kings of the Britons, they also suppressed their coins, and brought in their own; which were current here from the time of Claudius to that of Valentinian the younger, about the space of 500 years.

Mr Camden observes, that the most ancient English coin he had known was that of Ethelbert king of Kent, the first Christian king in the island; in whose time all money-accounts begin to pass by the names of *pounds, shillings, pence, and mancusæ*. Pence seems borrowed from the Latin *pecunia*, or rather from *pendo*, on account of its just weight, which was about three pence of our money. These were coarsely stamped with the king's image on the one side, and either the mint-master's, or the city's where it was coined, on the other. Five of these pence made their shilling, probably so called from *scillingus*, which the Romans used for the fourth part of an ounce. Forty of these shillings made their pound; and 400 of these pounds were a legacy, or a portion for a king's daughter, as appears by the last will of king Alfred. By these names they translated all sums of money in their old English testament; talents by *pundes*; Judas's thirty pieces of silver by *thirtig scillinga*; tribute-money, by *penning*; the mite by *seorthing*.

But it must be observed, they had no other real money, but pence only; the rest being imaginary moneys, *i. e.* names of numbers or weights. Thirty of these pence made a mancus, which some take to be the same with a mark; manca, as appears by an old MS. was *quinta pars uncie*. These mancus or mancusæ were reckoned both in gold and silver. For in the year 680, we read that Ina king of the West Saxons obliged the Kentishmen to buy their peace at the price of 30,000 mancusæ of gold. In the notes on king Canute's laws, we find this distinction, that *mancusæ* was as much as a mark of silver; and *manca* a square piece of gold, valued at 30 pence.

The Danes introduced a way of reckoning money by ores, *per oras*, mentioned in Domesday-book; but whether they were a several coin, or a certain sum, does not plainly appear. This, however, may be gathered from the Abbey-book of Burton, that 20 ores were equivalent to two marks. They had also a gold coin called *byzantine*, or *bezant*, as being coined at Constantinople, then called *Byzantium*. The value of which coin is not only now lost, but was so entirely forgot even in the time of king Edward III. that whereas the bishop of Norwich was fined a byzantine of gold to be paid the abbot of St Edmund's Bury for infringing his liberties (as it had been enacted by parliament in the time of the conqueror), no man then living could tell how much it was; so it was referred to the king to rate how much he should pay. Which is the more unaccountable, because but 100 years before, 200,000 bezants were exacted by the foldan for the ransom of St Lewis of France; which were then valued at 100,000 livres.

Money.

Though the coining of money be a special prerogative of the king, yet the ancient Saxon princes communicated it to their subjects; inasmuch that in every good town there was at least one mint; but at London eight, at Canterbury four for the king, two for the archbishop, one for the abbot at Winchester, six at Rochester, at Hastings two, &c.

The Norman kings continued the same custom of coining only pence, with the prince's image on one side, and on the other the name of the city where it was coined, with a cross so deeply impressed, that it might be easily parted and broke into two halves, which, so broken, they called *half-pence*; or into four parts, which they called *fourthings*, or *farthings*.

In the time of king Rich. I. money coined in the east parts of Germany, came in special request in England on account of its purity, and was called *eastling money*, as all the inhabitants of those parts were called *Eastlings*. And shortly after, some of those people skilled in coining were sent for hither, to bring the coin to perfection; which since has been called *sterling* for *Eastling*. See *STERLING*.

King Edward I. who first adjusted the measure of an ell by the length of his arm, herein imitating Charles the Great, was the first also who established a certain standard for the coin, which is expressed to this effect by Greg. Rockley, mayor of London, and mint-master.—“A pound of money containeth twelve ounces: in a pound there ought to be eleven ounces, two eastlings, and one farthing; the rest alloy. The said pound ought to weigh twenty shillings and three pence in account and weight. The ounce ought to weigh twenty pence, and a penny twenty-four grains and a half. Note, that eleven ounces two-pence Sterling ought to be of pure silver, called *leaf-silver*; and the minter must add of other weight seventeen-pence halfpenny farthing, if the silver be so pure.”

About the year 1320, the states of Europe first began to coin gold; and among the rest, our king Edward III. The first pieces he coined were called *florences*, as being coined by Florentines; afterwards he coined nobles; then rose-nobles, current at 6s. and 8d.; half-nobles, called *half-pennies*, at 3s. and 4d. of gold; and quarters at 20d. called *farthings* of gold. The succeeding kings coined rose-nobles, and double rose-nobles, great sovereigns, and half Henry nobles, angels, and shillings.

King James I. coined units, double crowns, Britain crowns: then crowns, half-crowns, &c.

II. *Imaginary Money, or Money of Account*, is that which has never existed, or at least which does not exist in real species, but is a denomination invented or retained to facilitate the stating of accounts, by keeping them still on a fixed footing, not to be changed, like current coins, which the authority of the sovereign raises or lowers according to the exigencies of the state. Of which kind are pounds, livres, marks, maravedis, &c. See the annexed TABLE, where the fictitious money is distinguished by a dagger (†).

*Moneys of Account among the Ancients*.—1. The Grecians reckoned their sums of money by *drachmæ, minæ, and talenta*. The drachma was equal to  $7\frac{1}{2}$  l. Sterling; 100 drachmæ made the mina, equal to 3l. 4s. 7d. Sterling; 60 mina made the talent, equal

10.

Money. to 193*l.* 15*s.* Sterling; hence 100 talents amounted to 19,375*l.* Sterling.

The mina and talentum, indeed, were different in different provinces: their proportions in Attic drachms are as follow. The Syrian mina contained 25 Attic drachms; the Ptolemaic 33½; the Antiochic and Eubæan 100; the Babylonian 116; the greater Attic and Syrian 133½; the Ægeian and Rhodian 166½. The Syrian talent contained 15 Attic minæ; the Ptolemaic 20; the Antiochic 60; the Eubæan 60; the Babylonian 70; the greater Attic and Tyrian 80; the Ægeian and Rhodian 100.

2. Roman moneys of account were the *sestertius* and *sestertium*. The sestertius was equal to 1*d.* 3¼*g.* Sterling. One thousand of these made the sestertium, equal to 8*l.* 1*s.* 5*d.* 2*g.* Sterling. One thousand of these sestertia made the decies sestertium (the adverb *centies* being always understood) equal to 8072*l.* 18*s.* 4*d.* Sterling. The decies sestertium they also called *decies centena millia nummum*. Centies sestertium, or centies HS, were equal to 80,720*l.* 3*s.* 4*d.* Millies HS to 807,201*l.* 13*s.* 4*d.* Millies centies HS to 888,020*l.* 16*s.* 8*d.*

## THEORY OF MONEY.

### I. Of Artificial or Material Money.

I. As far back as our accounts of the transactions of mankind reach, we find they had adopted the precious metals, that is, silver and gold, as the common measure of value, and as the adequate equivalent for every thing alienable.

The metals are admirably adapted for this purpose: they are perfectly homogeneous: when pure, their masses, or bulks, are exactly in proportion to their weights: no physical difference can be found between two pounds of gold, or silver, let them be the production of the mines of Europe, Asia, Africa, or America: they are perfectly malleable, fusible, and suffer the most exact division which human art is capable to give them: they are capable of being mixed with one another, as well as with metals of a baser, that is, of a less homogeneous nature, such as copper: by this mixture they spread themselves uniformly through the whole mass of the composed lump, so that every atom of it becomes proportionally possessed of a share of this noble mixture; by which means the subdivision of the precious metals is rendered very extensive.

Their physical qualities are invariable: they lose nothing by keeping; they are solid and durable; and tho' their parts are separated by friction, like every other thing, yet still they are of the number of those which suffer least by it.

If money, therefore, can be made of any thing, that is, if the proportional value of things vendible can be measured by any thing material, it may be measured by the metals.

II. The two metals being pitched upon as the most proper substances for realising the ideal scale of money, those who undertake the operation of adjusting a standard, must constantly keep in their eye the nature and qualities of a scale, as well as the principles upon which it is formed.

The unit of the scale must constantly be the same, altho' realised in the metals, or the whole operation

fails in the most essential part. This realising the unit is like adjusting a pair of compasses to a geometrical scale, where the smallest deviation from the exact opening once given must occasion an incorrect measure. The metals, therefore, are to money what a pair of compasses is to a geometrical scale.

This operation of adjusting the metals to the money of account implies an exact and determinate proportion of both metals to the money-unit, realised in all the species and denominations of coin, adjusted to that standard.

The smallest particle of either metal added to, or taken away from, any coins, which represent certain determinate parts of the scale, overturns the whole system of material money. And if, notwithstanding such variation, these coins continue to bear the same denominations as before, this will as effectually destroy their usefulness in measuring the value of things, as it would overturn the usefulness of a pair of compasses, to suffer the opening to vary, after it is adjusted to the scale representing feet, toises, miles, or leagues, by which the distances upon the plan are to be measured.

III. Debasing the standard is a good term; because it conveys a clear and distinct idea. It is diminishing the weight of the pure metal contained in that denomination by which a nation reckons, and which we have called the *money-unit*. Raising the standard requires no farther definition, being the direct contrary.

IV. Altering the standard (that is, raising or debasing the value of the money-unit) is like altering the national measures or weights. This is best discovered by comparing the thing altered with things of the same nature which have suffered no alteration. Thus if the foot of measure was altered at once over all England, by adding to it, or taking from it, any proportional part of its standard length, the alteration would be best discovered by comparing the new foot with that of Paris, or of any other country, which had suffered no alteration. Just so, if the pound Sterling, which is the English unit, shall be found any how changed, and if the variation it has met with be difficult to ascertain because of a complication of circumstances, the best way to discover it, will be to compare the former and the present value of it with the money of other nations which has suffered no variation. This the course of exchange will perform with the greatest exactness.

V. Artists pretend, that the precious metals, when absolutely pure from any mixture, are not of sufficient hardness to constitute a solid and lasting coin. They are found also in the mines mixed with other metals of a baser nature, and the bringing them to a state of perfect purity occasions an unnecessary expence. To avoid, therefore, the inconvenience of employing them in all their purity, people have adopted the expedient of mixing them with a determinate proportion of other metals, which hurts neither their fusibility, malleability, beauty, or lustre. This metal is called *alloy*; and, being considered only as a support to the principal metal, is accounted of no value in itself. So that eleven ounces of gold, when mixed with one ounce of silver, acquires, by that addition, no augmentation of value whatever.

Money.

This being the case, we shall, as much as possible, overlook the existence of alloy, in speaking of money, in order to render language less subject to ambiguity.

2. *Incapacities of the Metals to perform the Office of an invariable Measure of Value.*

I. WERE there but one species of such a substance as we have represented gold and silver to be; were there but one metal possessing the qualities of purity, divisibility, and durability; the inconveniences in the use of it for money would be fewer by far than they are found to be as matters stand.

Such a metal might then, by an unlimited division into parts exactly equal, be made to serve as a tolerably steady and universal measure. But the rivalry between the metals, and the perfect equality which is found between all their physical qualities, so far as regards purity and divisibility, render them so equally well adapted to serve as the common measure of value, that they are universally admitted to pass current as money.

What is the consequence of this? that the one measures the value of the other, as well as that of every other thing. Now the moment any measure begins to be measured by another, whose proportion to it is not physically, perpetually, and invariably the same, all the usefulness of such a measure is lost. An example will make this plain.

A foot of measure is a determinate length. An English foot may be compared with the Paris foot, or with that of the Rhine; that is to say, it may be measured by them; and the proportion between their lengths may be expressed in numbers; which proportion will be the same perpetually. The measuring the one by the other will occasion no uncertainty; and we may speak of length by Paris feet, and be perfectly well understood by others who are used to measure by the English foot, or by the foot of the Rhine.

But suppose that a youth of 12 years old takes it into his head to measure from time to time, as he advances in age, by the length of his own foot, and that he divides this growing foot into inches and decimals: what can be learned from his account of measures? As he increases in years, his foot, inches, and subdivisions, will be gradually lengthening; and were every man to follow his example, and measure by his own foot, then the foot of a measure now established would totally cease to be of any utility.

This is just the case with the two metals. There is no determinate invariable proportion between their value; and the consequence of this is, that when they are both taken for measuring the value of other things, the things to be measured, like lengths to be measured by the young man's foot, without changing their relative proportion between themselves, change, however, with respect to the denominations of both their measures. An example will make this plain.

Let us suppose an ox to be worth 3000 pounds weight of wheat, and the one and the other to be worth an ounce of gold, and an ounce of gold to be worth exactly 15 ounces of silver: if the case should happen, that the proportional value between gold and silver should come to be as 14 is to 1, would not the ox, and consequently the wheat, be estimated at less in sil-

ver, and more in gold, than formerly? Farther, would it be in the power of any state to prevent this variation in the measure of the value of oxen and wheat, without putting into the unit of their money less silver and more gold than formerly?

If therefore any particular state should fix the standard of the unit of their money to one species of the metals, while in fact both the one and the other are actually employed in measuring value; does not such a state resemble the young man who measures all by his growing foot? For if silver, for example, be retained as the standard, while it is gaining upon gold one fifteenth additional value; and if gold continue all the while to determine the value of things as well as silver; it is plain, that, to all intents and purposes, this silver-measure is lengthening daily like the young man's foot, since the same weight of it must become every day equivalent to more and more of the same commodity; notwithstanding that we suppose the same proportion to subsist, without the least variation, between that commodity and every other species of things alienable.

Buying and selling are purely conventional, and no man is obliged to give his merchandize at what may be supposed to be the proportion of its worth. The use, therefore, of an universal measure, is to mark, not only the relative value of the things to which it is applied as a measure, but to discover in an instant the proportion between the value of those, and of every other commodity valued by a determinate measure in all the countries of the world.

Were pounds Sterling, livres, florins, piales, &c. which are all money of account, invariable in their values, what a facility would it produce in all conversions, what an assistance to trade! But as they are all limited or fixed to coins, and consequently vary from time to time, this example shews the utility of the invariable measure which we have described.

There is another circumstance which incapacitates the metals from performing the office of money; the substance of which the coin is made, is a commodity which rises and sinks in its value with respect to other commodities, according to the wants, competition, and caprices of mankind. The advantage, therefore, found in putting an intrinsic value into that substance which performs the function of money of account, is compensated by the instability of that intrinsic value; and the advantage obtained by the stability of paper, or symbolical money, is compensated by the defect it commonly has of not being at all times susceptible of realization into solid property or intrinsic value.

In order, therefore, to render material money more perfect, this quality of metal, that is, of a commodity, should be taken from it; and in order to render paper-money more perfect, it ought to be made to circulate upon metallic or land-security.

II. There are several smaller inconveniences accompanying the use of the metals, which we shall here shortly enumerate.

1<sup>mo</sup>, No money made of gold or silver can circulate long, without losing of its weight, altho' it all along preserves the same denomination. This represents the contracting a pair of compasses which had been rightly adjusted to the scale.

2<sup>do</sup>, Another inconvenience proceeds from the fabrication of money. Supposing the faith of princes who coin money to be inviolable, and the probity as well as capacity of those to whom they commit the inspection of the fineness of the metals to be sufficient, it is hardly possible for workmen to render every piece exactly of a proper weight, or to preserve the due proportion between pieces of different denominations; that is to say, to make every ten sixpences exactly of the same weight with every crown-piece and every five shillings struck in a coinage. In proportion to such inaccuracies, the parts of the scale become unequal.

3<sup>io</sup>, Another inconvenience, and far from being inconsiderable, flows from the expence requisite for the coining of money. This expence adds to its value as a manufacture, withing adding any thing to its weight.

4<sup>to</sup>, The last inconvenience is, that by fixing the money of account entirely to the coin, without having any independent common measure, (to mark and control these deviations from mathematical exactness, which are either inseparable from the metals themselves, or from the fabrication of them), the whole measure of value, and all the relative interests of debtors and creditors, become at the disposal not only of workmen in the mint, of Jews who deal in money, of clippers and washers of coin; but they are also entirely at the mercy of princes, who have the right of coining, and who have frequently also the right of raising or debasing the standard of the coin, according as they find it most for their present and temporary interest.

3. *Methods which may be proposed for lessening the several Inconveniences to which Material Money is liable.*

THE inconveniences from the variation in the relative value of the metals to one another, may in some measure be obviated by the following expedients.

1<sup>mo</sup>, By considering one only as the standard, and leaving the other to seek its own value like any other commodity.

2<sup>do</sup>, By considering one only as the standard, and fixing the value of the other from time to time by authority, according as the market-price of the metals shall vary.

3<sup>io</sup>, By fixing the standard of the unit according to the mean proportion of the metals, attaching it to neither; regulating the coin accordingly; and upon every considerable variation in the proportion between them, either to make a new coinage, or to raise the denomination of one of the species, and lower it in the other, in order to preserve the unit exactly in the mean proportion between the gold and silver.

4<sup>to</sup>, To have two units and two standards, one of gold and one of silver, and to allow every body to stipulate in either.

5<sup>to</sup>, Or last of all, to oblige all debtors to pay one half in gold, and one half in the silver standard.

4. *Variations to which the Value of the Money-unit is exposed from every Disorder in the Coin.*

LET us suppose, at present, the only disorder to consist in a want of the due proportion between the gold

and silver in the coin.

This proportion can only be established by the market-price of the metals; because an augmentation and rise in the demand for gold or silver has the effect of augmenting the value of the metal demanded. Let us suppose, that to-day one pound of gold may buy fifteen pounds of silver: If to-morrow there be a high demand for silver, a competition among merchants to have silver for gold will ensue; they will contend who shall get the silver at the rate of 15 pounds for one of gold: this will raise the price of it; and in proportion to their views of profit, some will accept of less than the 15 pounds. This is plainly a rise in the silver, more properly than a fall in the gold; because it is the competition for the silver which has occasioned the variation in the former proportion between the metals.

Let us now suppose, that a state, having with great exactness examined the proportion of the metals in the market, and having determined the precise quantity of each for realising or representing the money-unit, shall execute a most exact coinage of gold and silver coin. As long as that proportion continues unvaried in the market, no inconvenience can result from that quarter in making use of metals for money of account.

But let us suppose the proportion to change; that the silver, for example, shall rise in its value with regard to gold: will it not follow, from that moment, that the unit realized in the silver, will become of more value than the unit realized in the gold coin?

But as the law has ordered them to pass as equivalents for one another, and as debtors have always the option of paying in what legal coin they think fit, will they not all choose to pay in gold, and will not then the silver coin be melted down or exported, in order to be sold as bullion, above the value it bears when it circulates in coin? Will not this paying in gold also really diminish the value of the money-unit, since upon this variation every thing must sell for more gold than before, as we have already observed?

Consequently, merchandize, which have not varied in their relative value to any other thing but to gold and silver, must be measured by the mean proportion of the metals; and the application of any other measure to them is altering the standard. If they are measured by the gold, the standard is debased; if by silver, it is raised.

If, to prevent the inconvenience of melting down the silver, the state shall give up affixing the value of their unit to both species at once, and shall fix it to one, leaving the other to seek its price as any other commodity; in that case, no doubt, the melting down of the coin will be prevented; but will ever this restore the value of the money-unit to its former standard? Would it, for example, in the foregoing supposition, raise the debased value of the money-unit in the gold coin, if that species were declared to be the standard? It would indeed render silver coin purely a merchandize, and, by allowing it to seek its value, would certainly prevent it from being melted down as before; because the pieces would rise conventionally in their denomination; or an *agio*, as it is called, would be taken in payments made in silver: but the gold would.

Money. would not, on that account, rise in its value, or begin to purchase any more merchandise than before. Were therefore the standard fixed to the gold, would not this be an arbitrary and a violent revolution in the value of the money-unit, and a debasement of the standard?

If, on the other hand, the state should fix the standard to the silver, which we suppose to have risen in its value, would that ever sink the advanced value which the silver coin had gained above the worth of the former standard unit? and would not this be a violent and an arbitrary revolution in the value of the money-unit, and a raising of the standard?

The only expedient, therefore, is, in such a case, to fix the numery unit to neither of the metals, but to contrive a way to make it fluctuate in a mean proportion between them; which is in effect the introduction of a pure ideal money of account.

The regulation of fixing the unit by the mean proportion, ought to take place at the instant the standard unit is affixed with exactness both to the gold and silver. If it be introduced long after the market-proportion between the metals has deviated from the proportion established in the coin; and if the new regulation is made to have a retrospect, with regard to the acquitting of permanent contracts entered into while the value of the money-unit had attached itself to the lowest currency in consequence of the principle above laid down; then the restoring the money-unit to that standard where it ought to have remained (to wit, to the mean proportion) is an injury to all debtors who have contracted since the time that the proportion of the metals began to vary.

This is clear from the former reasoning. The moment the market-price of the metals differs from that in the coin, every one who has payments to make, pays in that species which is the highest rated in the coin; consequently, he who lends, lends in that species. If after the contract, therefore, the unit is carried up to the mean proportion, this must be a loss to him who had borrowed.

From this we may perceive, why there is less inconvenience from the varying of the proportion of the metals, where the standard is fixed to one of them, than when it is fixed to both. In the first case, it is at least uncertain whether the standard or the merchandise species is to rise; consequently it is uncertain whether the debtors or the creditors are to gain by a variation. If the standard species should rise, the creditors will gain; if the merchandise species rises, the debtors will gain; but when the unit is attached to both species, then the creditors never can gain, let the metals vary as they will: if silver rises, then debtors will pay in gold; if gold rises, the debtors will pay in silver. But whether the unit be attached to one or to both species, the infallible consequence of a variation is, that one half of the difference is either gained or lost by debtors and creditors. The invariable unit is constantly the mean proportional between the two measures.

5. *How the Variations of the intrinsic Value of the Unit of Money must affect all the domestic Interest of a Nation.*

If the changing the content of the bushel by which

grain is measured, would affect the interest of those who are obliged to pay, or who are entitled to receive, a certain number of bushels of grain for the rent of lands; in the same manner must every variation in the value of the unit of account affect all persons who, in permanent contracts, are obliged to make payments, or who are entitled to receive sums of money stipulated in multiples or in fractions of that money-unit.

Every variation, therefore, upon the intrinsic value of the money-unit, has the effect of benefiting the class of creditors at the expence of debtors, or *vice versa*.

This consequence is deduced from an obvious principle. Money is more or less valuable in proportion as it can purchase more or less of every kind of merchandise. Now, without entering anew into the causes of the rise and fall of prices, it is agreed upon all hands, that whether an augmentation of the general mass of money in circulation has the effect of raising prices in general, or not, any augmentation of the quantity of the metals appointed to be put into the money-unit, must at least affect the value of that money-unit, and make it purchase more of any commodity than before: that is to say, if 113 grains of fine gold, the present weight of a pound Sterling in gold, can buy 113 pounds of flour; were the pound Sterling raised to 114 grains of the same metal, it would buy 114 pounds of flour; consequently, were the pound Sterling augmented by one grain of gold, every miller who paid a rent of ten pounds a-year, would be obliged to sell 1140 pounds of his flour, in order to procure ten pounds to pay his rent, in place of 1130 pounds of flour, which he sold formerly to procure the same sum; consequently, by this innovation, the miller must lose yearly ten pounds of flour, which his master consequently must gain. From this example, it is plain, that every augmentation of metals put into the pound Sterling, either of silver or gold, must imply an advantage to the whole class of creditors who are paid in pounds Sterling, and consequently must be a proportional loss to all debtors who must pay by the same denomination.

6. *Of the Disorder in the British Coin, so far as it occasions the melting down or the exporting of the Specie.*

THE defects in the British coin are three.

1<sup>mo</sup>, The proportion between the gold and silver in it is found to be as 1 to 15  $\frac{2}{3}$ , whereas the market price may be supposed to be nearly as 1 to 14  $\frac{1}{2}$ .

2<sup>do</sup>, Great part of the current money is worn and light.

3<sup>do</sup>, From the second defect proceeds the third, to wit, that there are several currencies in circulation which pass for the same value, without being of the same weight.

4<sup>to</sup>, From all these defects results the last and greatest inconvenience, to wit, that some innovation must be made, in order to set matters on a right footing.

The English, besides the unit of their money which they call the pound Sterling, have also the unit of their weight for weighing the precious metals.

This is called the pound troy, and consists of 12 ounces,

ounces, every ounce of 20 penny-weights, and every penny-weight of 24 grains. The pound troy, therefore, consists of 240 penny-weights, and 5760 grains.

The fineness of the silver is reckoned by the number of ounces and penny-weights of the pure metals in the pound troy of the compounded mass; or, in other words, the pound troy, which contains 5760 grains of standard silver, contains 5328 grains of fine silver, and 432 grains of copper, called *alloy*.

Thus standard silver is 11 ounces 2 penny-weights of fine silver in the pound troy to 18 penny-weights copper, or 111 parts fine silver to 9 parts alloy.

Standard gold is 11 ounces fine to 1 ounce silver or copper employed for alloy, which together make the pound troy; consequently, the pound troy of standard gold contains 5280 grains fine, and 480 grains alloy, which alloy is reckoned of no value.

This pound of standard silver is ordered, by statute of the 43d of Elizabeth, to be coined into 62 shillings, 20 of which make the pound sterling; consequently the 20 shillings contain 1718.7 grains of fine silver, and 1858.06 standard silver.

The pound troy of standard gold,  $\frac{11}{12}$  fine, is ordered, by an act of King Charles II. to becut into 44½ guineas; that is to say, every guinea contains 129.43 grains of standard gold, and 118.644 of fine gold; and the pound Sterling, which is  $\frac{2}{3}$  of the guinea, contains 112.994, which we may state at 113 grains of fine gold.

The coinage in England is entirely defrayed at the expense of the state. The mint price for the metals is the very same with the price of the coin. Whoever carries to the mint an ounce of standard silver, receives for it in silver coin 5s. 2d. or 62d.; whoever carries an ounce of standard gold receives in gold coin 3*l.* 17*s.* 10½*d.* the one and the other making exactly an ounce of the same fineness with the bullion. Coin, therefore, can have no value in the market above bullion; consequently, no loss can be incurred by those who melt it down.

When the guinea was first struck, the government (not inclining to fix the pound Sterling to the gold coin of the nation) fixed the guinea at 20 shillings, (which was then below its proportion to the silver), leaving it to seek its own price above that value, according to the course of the market.

By this regulation no harm was done to the English silver standard; because the guinea, or 118.644 grains fine gold being worth more, at that time, than 20 shillings, or 1718.7 grains fine silver, no debtor would pay with gold at its standard value; and whatever it was received for above that price was purely conventional.

Accordingly guineas sought their own price until the year 1728, that they were fixed a-new, not below their value as at first, but as what was then reckoned their exact value, according to the proportion of the metals, *viz.* at 21 shillings; and at this they were ordered to pass current in all payments.

This operation had the effect of making the gold a standard as well as the silver. Debtors then paid indifferently in gold as well as in silver, because both were supposed to be of the same intrinsic as well as current value; in which case no inconvenience could follow upon this regulation. But, in time, silver came to be more demanded; the making of plate began to pre-

vail more than formerly, and the exportation of silver to the East Indies increasing yearly, made the demand for it greater, or perhaps brought its quantity to be proportionally less than before. This changed the proportion of the metals; and by slow degrees they have come from that of 1 to 15.2 (the proportion they were supposed to have when the guineas were fixed and made a lawful money at 21 shillings) to that of 14.5, the present *supposed* proportion.

The consequence of this has been, that the same guinea which was worth 1804.6 grains fine silver, at the time it was fixed at 21 shillings, is now worth no more than 1719.9 grains of fine silver according to the proportion of 14½ to 1.

Consequently debtors, who have always the option of the legal species in paying their debts, will pay pounds sterling no more in silver but in gold; and as the gold pounds they pay in, are not intrinsically worth the silver pounds they paid in formerly according to the statute of Elizabeth, it follows that the pound sterling in silver is really no more the standard, since nobody will pay at that rate, and since nobody can be compelled to do it.

Besides this want of proportion between the metals, the silver coined before the reign of George I. is now become light by circulation; and the guineas coined by all the princes since Charles II. pass by tale, tho' many of them are considerably diminished in their weight.

Let us now examine what profit the want of proportion and the want of weight in the coin can afford to the money-jobbers in melting it down or exporting it.

Did every body consider coin only as the measure for reckoning value, without attending to its value as a metal, the deviations of gold and silver coin from perfect exactness, either as to proportion or weight, would occasion little inconvenience.

Great numbers indeed, in every modern society, consider coin in no other light than that of money of account; and have great difficulty to comprehend what difference any one can find between a light shilling and a heavy one, or what inconvenience there can possibly result from a guinea's being some grains of fine gold too light to be worth 21 shillings standard weight. And did every one think in the same way, there would be no occasion for coin of the precious metals at all; leather, copper, iron, or paper, would keep the reckoning as well as gold and silver.

But although there be many who look no farther than at the stamp on the coin, there are others whose sole business it is to examine its intrinsic worth as a commodity, and to profit of every irregularity in the weight and proportion of metals.

By the very institution of coinage, it is implied, that every piece of the same metal, and same denomination with regard to the money-unit, shall pass current for the same value.

It is, therefore, the employment of money-jobbers, to examine, with a scrupulous exactness, the precise weight of every piece of coin which comes into their hands.

The first object of their attention is, the price of the metals in the market: a jobber finds, at present, that with 14.5 pounds of fine silver bullion, he can buy

one pound of fine gold bullion.

He therefore buys up with gold coin all the new silver as fast as it is coined, of which he can get at the rate of 15.2 pounds for one in gold; these 15.2 pounds silver coin he melts down into bullion, and converts that back into gold bullion, giving at the rate of only 14.5 pounds for one.

By this operation he remains with the value of  $\frac{7}{12}$  of one pound weight of silver bullion clear profit upon the 15 $\frac{1}{2}$  pounds he bought; which  $\frac{7}{12}$  is really lost by the man who inadvertently coined silver at the mint, and gave it to the money-jobber for his gold. Thus the state loses the expence of the coinage, and the public the convenience of change for their guineas.

But here it may be asked, Why should the money-jobber melt down the silver coin? can he not buy gold with it as well without melting it down? He cannot; because when it is in coin, he cannot avail himself of its being new and weighty. Coin goes by tale, not by weight; therefore, were he to come to market with his new silver coin, gold bullion being sold at the mint price, we shall suppose, viz. at 3*l.* 17*s.* 10 $\frac{1}{2}$ *d.* Sterling money *per* ounce, he would be obliged to pay the price of what he bought with heavy money, which he can equally do with light.

He therefore melts down the new silver coin, and sells it for bullion, at so many pence an ounce; the price of which bullion is, in the English market, always above the price of silver at the mint, for the reasons now to be given.

When you sell standard-silver bullion at the mint, you are paid in weighty money; that is, you receive for your bullion the very same weight in standard coin; the coinage cost nothing; but when you sell bullion in the market, you are paid in worn out silver, in gold, in bank-notes, in short, in every species of lawful current money. Now all these payments have some defect: the silver you are paid with is worn and light; the gold you are paid with is overrated, and perhaps also light; and the bank-notes must have the same value with the specie with which the bank pays them; that is, with light silver or over-rated gold.

It is for these reasons, that silver bullion, which is bought by the mint at 5*s.* 2*d.* *per* ounce of heavy silver money, may be bought at market at 65 pence the ounce in light silver, over-rated gold, or bank-notes, which is the same thing.

Further, we have seen how the imposition of coinage has the effect of raising coin above the value of bullion, by adding a value to it which it had not as a metal.

Just so, when the unit is once affixed to certain determined quantities of both metals, if one of the metals should afterwards rise in value in the market, the coin made of that metal must lose a part of its value as coin, although it retains it as a metal. Consequently, as in the first case it acquired an additional value by being coined, it must now acquire an additional value by being melted down. From this we may conclude, that when the standard is affixed to both the metals in the coin, and when the proportion of that value is not made to follow the price of the market, that species which rises in the market is melted down, and the bullion is sold for a price as much exceeding the mint

price as the metal has risen in its value.

If, therefore, in England, the price of silver bullion is found to be at 65 pence the ounce, while at the mint it is rated at 62; this proves that silver has risen  $\frac{3}{8}$  above the proportion observed in the coin, and that all coin of standard weight may consequently be melted down with a profit of  $\frac{3}{8}$ . But as there are several other circumstances to be attended to which regulate and influence the price of bullion, we shall here pass them in review, the better to discover the nature of this disorder in the English coin, and the advantages which money-jobbers may draw from it.

The price of bullion, like that of every other merchandize, is regulated by the value of the money it is paid with.

If bullion, therefore, sells in England for 65 pence an ounce, paid in silver coin, it must sell for 65 shillings the pound troy; that is to say, the shillings it is commonly paid with do not exceed the weight of  $\frac{1}{12}$  of a pound troy: for if the 65 shillings with which the pound of bullion is paid weighed more than a pound troy, it would be a shorter and better way for him who wants bullion to melt down the shillings and make use of the metal, than to go to market with them in order to get less.

We may, therefore, be very certain, that no man will buy silver bullion at 65 pence an ounce, with any shilling which weighs above  $\frac{1}{12}$  of a pound troy.

We have gone upon the supposition that the ordinary price of bullion in the English market is 65 pence *per* ounce. This has been done upon the authority of some late writers on this subject: it is now proper to point out the causes which may make it deviate from that value.

I. It may vary, and certainly will vary, in the price, according as the currency is better or worse. When the expences of a war, or a wrong balance of trade, have carried off a great many heavy guineas, it is natural that bullion should rise; because then it will be paid for more commonly in light gold and silver; that is to say, with pounds Sterling, below the value of 113 grains fine gold, the worth of the pound Sterling in new guineas.

II. This wrong balance of trade, or a demand for bullion abroad, becoming very great, may occasion a scarcity of the metals in the market, as well as a scarcity of the coin; consequently, an advanced price must be given for it in proportion to the greatness and height of the demand. In this case, both the specie and the bullion must be bought with paper. But the rise in the price of bullion proceeds from the demand for the metals and the competition between merchants to procure them, and not because the paper given as the price is at all of inferior value to the specie. The least discredit of this kind would not tend to diminish the value of the paper; it would annihilate it at once. Therefore, since the metals must be had, and that the paper cannot supply the want of them when they are to be exported, the price rises in proportion to the difficulties in finding metals elsewhere than in the English market.

III. A sudden call for bullion, for the making of plate. A goldsmith can well afford to give 67 pence for an ounce of silver, that is to say, he can afford to give one pound of gold for 14 pounds of silver, and perhaps for



Money. for less, notwithstanding that what he gives be more than the ordinary proportion between the metals, because he indemnifies himself amply by the price of his workmanship; just as a tavern-keeper will pay any price for a fine fish, because, like the goldsmith, he buys for other people.

IV. The mint price has as great an effect in bringing down the price of bullion, as exchange has in raising it. In countries where the metals in the coin are justly proportioned, where all the currencies are of legal weight, and where coinage is imposed, the operations of trade make the price of bullion constantly to fluctuate between the value of the coin and the mint-price of the metals.

Now let us suppose that the current price of silver bullion in the market is 65 pence the ounce, paid in lawful money, no matter of what weight or of what metal. Upon this the money-jobber falls to work. All shillings which are above  $\frac{1}{8}$  of a pound troy, he throws into his melting pot, and sells them as bullion for 65d. per ounce; and all those which are below that weight he carries to market, and buys bullion with them at 65d. per ounce.

What is the consequence of this?

That those who sell the bullion, finding the shillings which the money-jobber pays with perhaps not above  $\frac{1}{8}$  of a pound troy, they on their side raise the price of their bullion to 66 d. the ounce.

This makes new work for the money-jobber; for he must always gain. He now weighs all shillings as they come to hand, and as formerly he threw into his melting-pot those only which were worth more than  $\frac{1}{8}$  of a pound troy, he now throws in all that are in value above  $\frac{1}{8}$ . He then sells the melted shillings at 66 d. the ounce, and buys bullion with the light ones at the same price.

This is the consequence of ever permitting any species of coin to pass by the authority of the stamp, without controlling it at the same time by the weight; and this is the manner in which money-jobbers gain by the currency of light money.

It is no argument against this exposition of the matter to say, that silver bullion is seldom bought with silver coin; because the pence in new guineas are worth no more than the pence of shillings of 65 in the pound troy: that is to say, that 240 pence contained in  $\frac{3}{4}$  of a new guinea, and 240 pence contained in 28 shillings of 65 to the pound troy, differ no more in the intrinsic value than 0.83 of a grain of fine silver upon the whole, which is a mere trifle.

Whenever, therefore, shillings come below the weight of  $\frac{3}{4}$  of a pound troy, then there is an advantage in changing them for new guineas; and when that is the case, the new guineas will be melted down, and profit will be found in selling them for bullion, upon the principles we have just been explaining.

We have already given a specimen of the domestic operations of the money-jobbers; but these are not the most prejudicial to national concerns. The jobbers may be supposed to be Englishmen; and in that case the profit they make remains at home: but whenever there is a call for bullion to pay the balance of trade, it is evident that this will be paid in silver coin, never in gold, if heavy silver can be got;

and this again carries away the silver coin, and renders it at home so rare, that great inconveniences are found for want of the lesser denominations of it. The loss, however, here is confined to an inconvenience; because the balance of trade being a debt which must be paid, we do not consider the exportation of the silver for that purpose as any consequence of the disorder of the coin. But besides this exportation which is necessary, there are others which are arbitrary, and which are made only with a view to profit of the wrong proportion.

When the money-jobbers find difficulty in carrying on the traffic we have described, in the English market, because of the competition among themselves, they carry the silver coin out of the country, and sell it abroad for gold, upon the same principles that the East India company send silver to China in order to purchase gold.

It may be demanded, What hurt this trade can do to Britain, since those who export silver bring back the same value in gold? Were this trade carried on by natives, there would be no loss; because they would bring home gold for the whole intrinsic value of the silver. But if we suppose foreigners sending over gold to be coined at the English mint, and changing the gold into English silver coin, and then carrying off this coin, it is plain that they must gain the difference, as well as the money-jobbers. But it may be answered, That having given gold for silver at the rate of the mint, they have given value for what they have received. Very right; but so did Sir Hans Sloane, when he paid five guineas for an overgrown tod: he got value for his money; but it was value only to himself. Just so, whenever the English government shall be obliged to restore the proportion of the metals, (as they must do,) this operation will annihilate that imaginary value which they have hitherto set upon gold; which imagination is the only thing which renders the exchange of their silver against the foreign gold equal.

But it is farther objected, that foreigners cannot carry off the heavy silver; because there is none to carry off. Very true; but then they have carried off a great quantity already: or if the English Jews have been too sharp to allow such a profit to fall to strangers, (which may or may not have been the case,) then this disorder is an effectual stop to any more coinage of silver for circulation.

7. *Of the Disorder in the British Coin, so far as it affects the Value of the Pound Sterling Currency.*

From what has been said, it is evident, that there must be found in England two legal pounds Sterling, of different values; the one worth 113 grains of fine gold, the other worth 1718.7 grains of fine silver. We call them different; because these two portions of the precious metals are of different values all over Europe.

But besides these two different pounds Sterling, which the change in the proportion of the metals have created, the other defects of the circulating coin produce similar effects. The guineas coined by all the princes since K. Charles II. have been of the same standard weight and fineness,  $44\frac{1}{2}$  in a pound troy of standard gold  $\frac{1}{17}$  fine: these have been constantly

Money. wearing ever since they have been coined; and in proportion to their wearing they are of less value.

If, therefore, the new guineas are below the value of a pound Sterling in silver, standard weight, the old must be of less value still. Here then is another currency, that is, another pound Sterling; or indeed, more properly speaking, there are as many different pounds Sterling as there are guineas of different weights. This is not all; the money-jobbers having carried off all the weighty silver, that which is worn with use, and reduced even below the standard of gold, forms one currency more, and totally destroys all determinate proportion between the money-unit and the currencies which are supposed to represent it.

It may be asked, how, at this rate, any silver has remained in England? It is answered, that the few weighty shillings which still remain in circulation, have marvellously escaped the hands of the money-jobbers; and as for the rest, the rubbing and wearing of these pieces has done what the state might have done; that is to say, it has reduced them to their due proportion with the lightest gold.

The disorder, therefore, of the English coin has rendered the standard of a pound Sterling quite uncertain. To say that it is 1718.7 grains of fine silver, is quite ideal. Who are paid in such pounds? To say that it is 113 grains of pure gold, may also not be true; because there are many currencies worse than the new guineas.

What then is the consequence of all this disorder; What effect has it upon the current value of a pound Sterling? And which way can the value of that be determined?

The operations of trade bring value to an equation, notwithstanding the greatest irregularities possible; and so in fact a pound Sterling has acquired a determinate value over all the world by the means of foreign exchange. This is a kind of ideal scale for measuring the British coin, altho' it has not all the properties of that described above.

Exchange considers the pound Sterling as a value determined according to the combination of the values of all the different currencies, in proportion as payments are made in the one or the other; and as debtors generally take care to pay in the worst species they can, it consequently follows, that the value of the pound Sterling should fall to that of the lowest currency.

Were there a sufficient quantity of worn gold and silver to acquit all bills of exchange, the pound Sterling would come down to the value of them; but if the new gold be also necessary for that purpose, the value of it must be proportionally greater.

All these combinations are liquidated and compensated with one another, by the operations of trade and exchange; and the pound Sterling, which is so different in itself, becomes thereby, in the eyes of commerce, a determinate unit; subject, however, to variations, from which it never can be exempted.

Exchange, therefore, is one of the best measures for valuing a pound Sterling, present currency. Here occurs a question:

Does the great quantity of paper-money in Eng-

land tend to diminish the value of the pound Sterling? Money.

We answer in the negative. Paper money is just as good as gold or silver money, and no better. The variation of the standard, as we have already said, most influence the interests of debtors and creditors proportionally every where. From this it follows, that all augmentation of the value of the money-unit in the specie must hurt the debtors in the paper money; and all diminutions, on the other hand, must hurt the creditors in the paper money as well as every where else. The payments, therefore, made in paper money, never can contribute to the regulation of the standard of the pound Sterling; it is the specie received in liquidation of that paper money which alone can contribute to mark the value of the British unit; because it is affixed to nothing else.

From this we may draw a principle, "That in countries where the money-unit is entirely affixed to the coin, the actual value of it is not according to the legal standard of that coin, but according to the mean proportion of the actual worth of those currencies in which debts are paid.

From this we see the reason why the exchange between England and all other trading towns in Europe has long appeared so unfavourable. People calculate the real par, upon the supposition that a pound Sterling is worth 1718.7 grains troy of fine silver, when in fact the currency is not perhaps worth 1638, the value of a new guinea in silver, at the market proportion of 1 to 14.5; that is to say, the currency is but 95.3 per cent. of the silver standard of the 43d of Elizabeth. No wonder then if the exchange be thought unfavourable.

From the principle we have just laid down, we may gather a confirmation of what we advanced concerning the cause of the advanced price of bullion in the English market.

When people buy bullion with current money at a determinate price, that operation, in conjunction with the course of exchange, ought naturally to mark the actual value of the pound Sterling with great exactness.

If therefore the price of standard bullion in the English market, when no demand is found for the exportation of the metals, that is to say, when paper is found for paper upon exchange, and when merchants versed in these matters judge exchange (that is, remittances) to be at par, if then silver bullion cannot be brought at a lower price than 65 pence the ounce, it is evident that this bullion might be bought with 65 pence in shillings, of which 65 might be coined out of the pound troy English standard silver; since 65 per ounce implies 65 shillings for the 12 ounces or pound troy.

This plainly shews how standard silver bullion should sell for 65 pence the ounce, in a country where the ounce of standard silver in the coin is worth no more than 62; and were the market-price of bullion to stand uniformly at 65 pence per ounce, that would shew the value of the pound Sterling to be tolerably fixed. All the heavy silver coin is now carried off; because it was intrinsically worth more than the gold it passed for in currency. The silver therefore which remains is worn down to the market proportion of the metals.

Money. metals, as has been said; that is to say, 20 shillings in silver currency are worth 113 grains of fine gold, at the proportion of 1 to 14.5 between gold and silver. Now,

as 1 is to 14.5, so is 113 to 1638 :

so the 20 shillings current weigh but 1638 grains fine silver, instead of 1718.7, which they ought to do according to the standard.

Now let us speak of standard silver, since we are examining how far the English coin must be worn by use.

The pound troy contains 5760 grains. This, according to the standard, is coined into 62 shillings; consequently, every shilling ought to weigh 92.9 grains. Of such shillings it is impossible that ever standard bullion should fell at above 62 pence *per* ounce. If therefore such bullion sells for 65 pence, the shillings with which it is bought must weigh no more than 88.64 grains standard silver; that is, they must lose 4.29 grains, and are reduced to  $\frac{2}{3}$  of a pound troy.

But it is not necessary that bullion be bought with shillings; no stipulation of price is ever made farther, than at so many pence Sterling *per* ounce. Does not this virtually determine the value of such currency with regard to all the currencies in Europe? Did a Spaniard, a Frenchman, or a Dutchman, know the exact quantity of silver bullion which can be bought in the London market for a pound Sterling, would he inform himself any farther as to the intrinsic value of that money-unit; would he not understand the value of it far better from that circumstance than by the course of any exchange, since exchange does not mark the intrinsic value of money, but only the value of that money transported from one place to another?

The price of bullion, therefore, when it is not influenced by extraordinary demand, (such as for the payment of a balance of trade, or for making an extraordinary provision of plate), but when it stands at what every body knows to be meant by the common market price, is a very tolerable measure of the value of the actual money-standard in any country.

If it be therefore true, that a pound Sterling cannot purchase above 1638 grains of fine silver bullion, it will require not a little logic to prove that it is really, or has been for these many years, worth any more; notwithstanding that the standard weight of it in England is regulated by the laws of the kingdom at 1718.7 grains of fine silver.

If to this valuation of the pound Sterling drawn from the price of bullion, we add the other drawn from the course of exchange; and by this we find, that when paper is found for paper upon exchange, a pound Sterling cannot purchase above 1638 grains of fine silver in any country in Europe: upon these two authorities we may very safely conclude (as to the matter of fact at least) that the pound Sterling is not worth more, either in London or in any other trading city; and if this be the case, it is just worth 20 shillings of 65 to the pound troy.

If therefore the mint were to coin shillings at that rate, and pay for silver bullion at the market price, that is, at the rate of 65 pence *per* ounce in those new coined shillings, they would be in proportion to the

gold; silver would be carried to the mint equally with gold, and would be as little subject to be exported or melted down.

It may be inquired in this place, how far the coining the pound troy into 65 shillings is contrary to the laws of England?

The moment a state pronounces a certain quantity of gold to be worth a certain quantity of silver, and orders these respective quantities of each metal to be received as equivalents of each other and as lawful money in payments, that moment gold is made a standard as much as silver. If therefore too small a quantity of gold be ordered or permitted to be considered as an equivalent for the unit, the silver standard is from that moment debased; or indeed, more properly speaking, all silver money is from that moment proscribed; for who, from that time, will ever pay in silver, when he can pay cheaper in gold? Gold, therefore, by such a law, is made the standard, and all declarations to the contrary are against the matter of fact.

Were the king, therefore, to coin silver at 65 shillings in the pound, it is demonstration, that by such an act he would commit no adulteration upon the standard: the adulteration is already committed. The standard has descended to where it is by slow degrees, and by the operation of political causes only; and nothing prevents it from falling lower but the standard of the gold coin. Let guineas be now left to seek their value as they did formerly, and let light silver continue to go by tale, we shall see the guineas up to 30 shillings in 20 years time, as was the case in 1695.

It is as absurd to say that the standard of Queen Elizabeth has not been debased by enacting that the English unit shall be acquitted with 113 grains of fine gold, as it would be to affirm that it would not be debased from what it is at present by enacting that a pound of butter should every where be received in payment for a pound Sterling; although the pound Sterling should continue to consist of 3 ounces, 17 pennyweights, and 10 grains of standard silver, according to the statute of the 43d of Elizabeth. In that case most debtors would pay in butter, and silver would, as at present, acquire a conventional value as a metal, but would be looked upon no longer as a standard, or as money.

If therefore, by the law of England, a pound Sterling must consist of 1718.7 grains troy of fine silver; by the law of England also, 113 grains of gold must be of the same value: but no law can establish that proportion; consequently, in which ever way a reformation be brought about, some law must be reversed; consequently, expediency, and not compliance with law, must be the motive in reforming the abuse.

From what has been said, it is not at all surprising that the pound Sterling should in fact be reduced nearly to the value of the gold. Whether it ought to be kept at that value is another question. All that we here decide, is, that coining the pound troy into 65 shillings would restore the proportion of the metals, and render both species common in circulation. But restoring the weight and proportion of the coin is not the difficulty which prevents a reformation of the English coinage.

8. *Circumstances to be attended to in a new Regulation of the British Coin.*

To people who do not understand the nature of such operations, it may have an air of justice to support the unit at what is commonly believed to be the standard of Queen Elizabeth, *viz.* at 1718.7 grains of fine silver.

The regulating the standard of both silver and gold to  $\frac{1}{11}$  fine, and the pound Sterling to four ounces standard silver, as it stood during the reign of Queen Mary I. has also its advantages, as Mr Harris has observed. It makes the crown-piece to weigh just one ounce, the shilling four penny-weight, and the penny eight grains; consequently, were the new statute to bear, that the weight of the coin should regulate its currency upon certain occasions, the having the pieces adjusted to certain aliquot parts of weight would make weighing easy, and would accustom the common people to judge of the value of money by its weight, and not by the stamp.

In that case, there might be a conveniency in striking the gold coins of the same weight with the silver; because the proportion of their values would then constantly be the same with the proportion of the metals. The gold crowns would be worth at present, 3*l.* 12*s.* 6*d.* the half crowns 1*l.* 16*s.* 3*d.* the gold shillings 14*s.* and 6*d.* and the half 7*s.* and 3*d.* This was anciently the practice in the Spanish mints.

The interests within the state can be nowise perfectly protected but by permitting conversions of value from the old to the new standard, whatever it be, and by regulating the footing of such conversions by act of parliament, according to circumstances.

For this purpose, we shall examine those interests which will chiefly merit the attention of government, when they form a regulation for the future of acquitting permanent contracts already entered into. Such as may be contracted afterwards will naturally follow the new standard.

The landed interest is, no doubt, the most considerable in the nation. Let us therefore examine, in the first place, what regulations it may be proper to make, in order to do justice to this great class, with respect to the land-tax on one hand, and with respect to their lessees on the other.

The valuation of the lands of England was made many years ago, and reasonably ought to be supported at the real value of the pound Sterling at that time, according to the principles already laid down. The general valuation, therefore, of the whole kingdom will rise according to this scheme. This will be considered as an injustice; and no doubt it would be so, if, for the future, the land-tax be imposed as heretofore, without attending to this circumstance; but as that imposition is annual, as it is laid on by the landed-interest itself, who compose the parliament, it is to be supposed that this great class will at least take care of their own interest.

Were the valuation of the lands to be stated according to the valuation of the pound Sterling of 1718.7 grains of silver, which is commonly supposed to be the standard of Elizabeth, there would be no great injury done: this would raise the valuation only 5 *per cent.* and the land-tax in proportion.

There is no class of inhabitants in all England so much at their ease, and so free from taxes, as the class of farmers. By living in the country, and by consuming the fruits of the earth without their suffering any alienation, they avoid the effect of many excises, which, by those who live in corporations, are felt upon many articles of their consumption, as well as on those which are immediately loaded with these impositions. For this reason it will not, perhaps, appear unreasonable, if the additional 5 *per cent.* on the land-tax were thrown upon this class, and not upon the landlords.

With respect to leases, it may be observed, that we have gone upon the supposition that the pound Sterling in the year 1728, was worth 1718.7 grains of fine silver, and 113 grains of fine gold.

There would be no injustice done the lessees of all the lands in the kingdom, were their rents to be fixed at the mean proportion of these values. We have observed how the pound Sterling has been gradually diminishing in its worth from that time by the gradual rise of the silver. This mean proportion, therefore, will nearly answer to what the value of the pound Sterling was in 1743; supposing the rise of the silver to have been uniform.

It may be farther alleged in favour of the landlords, that the gradual debasement of the standard has been more prejudicial to their interest in letting their lands, than to the farmers in disposing of the fruits of them. Proprietors cannot so easily raise their rents upon new leases, as farmers can raise the prices of their grain according to the debasement of the value of the currency.

The pound Sterling, thus regulated at the mean proportion of its worth, as it stands at present, and as it stood in 1728, may be realized in 1698.6 grains of fine silver, and 115.76 grains fine gold: which is 2.4 *per cent.* above the value of the present currency. No injury, therefore, would be done to lessees, and no unreasonable gain would accrue to the landed interest, in appointing conversions of all land-rents at 2  $\frac{1}{2}$  *per cent.* above the value of the present currency.

Without a thorough knowledge of every circumstance relating to Great Britain, it is impossible to lay down any plan. It is sufficient here briefly to point out the principles upon which it must be regulated.

The next interest to be considered is that of the nation's creditors. The right regulation of their concerns will have a considerable influence in establishing public credit upon a solid basis, by making it appear to all the world, that no political operation upon the money of Great Britain can in any respect either benefit or prejudice the interest of those who lend their money upon the faith of the nation. The regulating also the interest of so great a body, will serve as a rule for all creditors who are in the same circumstances, and will, upon other accounts, be productive of greater advantages to the nation in time coming.

In 1749, a new regulation was made with the public creditors, when the interest of the whole redeemable national debt was reduced to 3 *per cent.* This circumstance infinitely facilitates the matter with respect to this class, since, by this innovation of all former contracts, the whole national debt may be considered as contracted at, or posterior to, the 25th of December 1749.

Were the state, by any arbitrary operation upon money, (which every reformation must be), to diminish the value of the pound Sterling in which the parliament at that time bound the nation to acquit those capitals and the interest upon them, would not all Europe say, That the British parliament had defrauded their creditors? If therefore the operation proposed to be performed should have a contrary tendency, viz. to augment the value of the pound Sterling with which the parliament at that time bound the nation to acquit those capitals and interests, must not all Europe also agree, That the British parliament had defrauded the nation?

This convention with the ancient creditors of the state, who, in consequence of the debasement of the standard, might have justly claimed an indemnification for the loss upon their capitals, lent at a time when the pound Sterling was at the value of the heavy silver, removes all cause of complaint from that quarter. There was in the year 1749 an innovation in all their contracts; and they are now to be considered as creditors only from the 25th of December of that year.

Let the value of the pound Sterling be inquired into during one year preceding and one posterior to the transaction of the month of December 1749. The great sums borrowed and paid back by the nation during that period, will furnish data sufficient for that calculation. Let this value of the pound be specified in troy grains of fine silver and fine gold bullion, without mentioning any denomination of money according to the exact proportion of the metals at that time. And let this pound be called the *pound of national credit*.

This first operation being determined, let it be enacted, that the pound Sterling, by which the state is to borrow for the future, and that in which the creditors are to be paid, shall be the exact mean proportion between the quantities of gold and silver above specified, according to the actual proportion of the metals at the time such payments shall be made: or that the sums shall be borrowed or acquitted, one half in gold and one half in silver, at the respective requisitions of the creditors or of the state, when borrowing. All debts contracted posterior to 1749 may be made liable to conversions.

The consequence of this regulation will be the inflexible establishment of a bank-money. Nothing would be more difficult to establish, by a positive revolution, than such an invariable measure; and nothing will be found so easy as to let it establish itself by its own advantages. This bank-money will be liable to much fewer inconveniences than that of Amsterdam. There the persons transacting must be upon the spot; here, the Sterling currency may, every quarter of a year, be adjusted by the exchequer to this invariable standard, for the benefit of all debtors and creditors, who incline to profit of the stability of this measure of value.

This scheme is liable to no inconvenience from the variation of the metals, let them be ever so frequent, or hard to be determined; because upon every occasion where there is the smallest doubt as to the actual proportion, the option competent to creditors to be paid half in silver and half in gold will remove.

Such a regulation will also have this good effect, that it will give the nation more just ideas of the nature of money, and consequently of the influence it ought to have upon prices.

If the value of the pound Sterling shall be found to have been by accident less in December 1749 than it is at present; or if at present the currency be found below what has commonly been since 1749; in justice to the creditors, and to prevent all complaints, the nation may grant them the mean proportion of the value of the pound sterling from 1749 to 1760, or any other which may to parliament appear reasonable.

This regulation must appear equitable in the eyes of all Europe; and the strongest proof of it will be, that it will not produce the smallest effect prejudicial to the interest of the foreign creditors. The course of exchange with regard to them will stand precisely as before.

A Dutch, French, or German creditor, will receive the same value for his interest in the English stocks as heretofore. This must silence all clamours at home, being the most convincing proof, that the new regulation of the coin will have made no alteration upon the real value of any man's property, let him be debtor or creditor.

The interest of every other denomination of creditors, whose contracts are of a fresh date, may be regulated upon the same principles. But where debts are of an old standing, justice demands, that attention be had to the value of money at the time of contracting. Nothing but the stability of the English coin, when compared with that of other nations, can make such a proposal appear extraordinary. Nothing is better known in France than this stipulation added to obligations, *Argent au cours de ce jour*; that is to say, That the sum shall be repaid in coin of the same intrinsic value with what has been lent. Why should such a clause be thought reasonable for guarding people against arbitrary operations upon the numerary value of the coin, and not be found just upon every occasion where the numerary value of it is found to be changed, let the cause be what it will?

The next interest we shall examine is that of trade. When men have attained the age of 21, they have no more occasion for guardians. This may be applied to traders: they can parry with their pen every inconvenience which may result to other people from the changes upon money, provided only the laws permit them to do themselves justice with respect to their engagements. This class demands no more than a right to convert all reciprocal obligations into denominations of coin of the same intrinsic value with those they have contracted in.

The next interest is that of buyers and sellers; that is, of manufacturers with regard to consumers, and of servants with respect to those who hire their personal service.

The interest of this class requires a most particular attention. They must, literally speaking, be put to school, and taught the first principles of their trade, which is buying and selling. They must learn to judge of price by the grains of silver and gold they receive: they are children of a mercantile mother, however warlike the father's disposition. If it be the interest of the state that their bodies be rendered robust and active,

Money. it is no less the interest of the state that their minds be instructed in the first principles of the trade they exercise.

For this purpose, tables of conversion from the old standard to the new must be made, and ordered to be put up in every market, in every shop. All duties, all excises, must be converted in the same manner. Uniformity must be made to appear every where. The smallest deviation from this will be a stumbling-block to the multitude.

Not only the interest of the individuals of the class we are at present considering, demands the nation's care and attention in this particular; but the prosperity of trade, and the well-being of the nation, are also deeply interested in the execution.

The whole delicacy of the intricate combinations of commerce depends upon a just and equable vibration of prices, according as circumstances demand it. The more therefore the industrious classes are instructed in the principles which influence prices, the more easily will the machine move. A workman then learns to sink his price without regret, and can raise it without avidity. When principles are not understood, prices cannot gently fall, they must be pulled down; and merchants dare not suffer them to rise, for fear of abuse, even although the perfection of an infant-manufacture should require it.

The last interest is that of the bank of England, which naturally must regulate that of every other.

Had this great company followed the example of other banks, and established a bank-money of an invariable standard as the measure of all their debts and credits, they would not have been liable to any inconvenience upon a variation of the standard.

The bank of England was projected about the year 1694, at a time when the current money of the nation was in the greatest disorder, and government in the greatest distress both for money and for credit. Commerce was then at a very low ebb; and the only, or at least the most profitable, trade of any, was jobbing in coin, and carrying backwards and forwards the precious metals from Holland to England. Merchants profited also greatly from the effects which the utter disorder of the coin produced upon the price of merchandise.

At such a juncture the resolution was taken to make a new coinage; and upon the prospect of this, a company was found, who, for an exclusive charter to hold a bank for 13 years, willingly lent the government upwards of a million Sterling at 8 per cent. (in light money we suppose), with a prospect of being repaid both interest and capital in heavy. This was not all: part of the money lent was to be applied for the establishment of the bank; and no less than 4000l. a-year was allowed to the company, above the full interest, for defraying the charge of the management.

Under such circumstances the introduction of bank-money was very superfluous, and would have been very impolitic. That invention is calculated against the raising of the standard: but here the bank profited of that rise in its quality of creditor for money lent; and took care not to commence debtor by circulating their paper, until the effect of the new regulation took place in 1695; that is, after the general re-coinage of all the clipped silver.

Money. From that time till now, the bank of England has been the basis of the nation's credit, and with great reason has been constantly under the most intimate protection of every minister.

The value of the pound Sterling, as we have seen, has been declining ever since the year 1601, the standard being fixed to silver during all that century, while the gold was constantly rising. No sooner had the proportion taken another turn, and silver begun to rise, than the government of England threw the standard virtually upon the gold, by regulating the value of the guineas at the exact proportion of the market. By these operations, however, the bank has constantly been a gainer (in its quality of debtor) upon all the paper in circulation; and therefore has lost nothing by not having established a bank-money.

The interest of this great company being established upon the principles we have endeavoured to explain, it is very evident, that the government of England never will take any step in the reformation of the coin which in its consequences can prove hurtful to the bank. Such a step would be contrary both to justice and to common sense. To make a regulation which, by raising the standard, will prove beneficial to the public creditors, to the prejudice of the bank, (which we may call the *public debtor*) would be an operation upon public credit, like that of a person who is at great pains to support his house by props upon all sides, and who at the same time blows up the foundation of it with gunpowder.

We may therefore conclude, that with regard to the bank of England, as well as every other private banker, the notes which are constantly payable upon demand must be made liable to a conversion at the actual value of the pound Sterling at the time of the new regulation.

That the bank will gain by this, is very certain; but the circulation of their notes is so swift, that it would be absurd to allow to the then possessors of them that indemnification which naturally should be shared by all those through whose hands they have passed, in proportion to the debasement of the standard during the time of their respective possession.

Besides these considerations, which are in common to all states, the government of Great Britain has one peculiar to itself. The interest of the bank, and that of the creditors, are diametrically opposite: every thing which raises the standard, hurts the bank; every thing which can sink it, hurts the creditors; and upon the right management of the one and the other, depends the solidity of public credit. For these reasons, without the most certain prospect of conducting a restitution of the standard to the general advantage as well as approbation of the nation, no minister will probably ever undertake so dangerous an operation.

We shall now propose an expedient which may remove at least some of the inconveniences which would result from so extensive an undertaking as that of regulating the respective interests in Great Britain by a positive law, upon a change in the value of their money of account.

Suppose then, that, before any change is made in the coin, government should enter into a transaction with the public creditors, and ascertain a permanent value

Money. value for the pound sterling for the future, specified in a determined proportion of the fine metals in common bullion, without any regard to money of account, or to any coin whatever.

Money. above-determined shall be constantly observed through every denomination of the coin, until necessity shall make a new general coinage unavoidable.

This preliminary step being taken, let the intended alteration of the standard be proclaimed a certain time before it is to commence. Let the nature of the change be clearly explained, and let all such as are engaged in contracts which are dissolvable at will upon the stipulations stipulated, be acquitted between the parties, or innovated as they shall think proper; with certification, that, posterior to a certain day, the stipulations formerly entered into shall be binding according to the denominations of the money of account in the new standard.

5. To have the number of grains of the fine metal in every piece marked upon the exergue, or upon the legend of the coin, in place of some initial letters of titles, which not one person in a thousand can decipher; and to make the coin of as compact a form as possible, diminishing the surface of it as much as is consistent with beauty.

As to permanent contracts, which cannot at once be fulfilled and dissolved, such as leases, the parliament may either prescribe the methods and terms of conversion; or a liberty may be given to the parties to annul the contract, upon the debtor's refusing to perform his agreement according to the new standard. Contracts, on the other hand, might remain stable, with respect to creditors who would be satisfied with payments made on the footing of the old standard. If the rise intended should not be very considerable, no great injustice can follow such a regulation.

6. That it shall be lawful for all contracting parties to stipulate their payments either in gold or silver coin, or to leave the option of the species to one of the parties.

Annuities are now thoroughly understood, and the value of them is brought to so nice a calculation, that nothing will be easier than to regulate these upon the footing of the value paid for them, or of the subject affected by them. If by the regulation, land-rents are made to rise in denomination, the annuities charged upon them ought to rise in proportion; if in intrinsic value, the annuity should remain as it was.

7. That where no particular stipulation is made, creditors shall have power to demand payment, half in one species, half in the other; and when the sum cannot fall equally into gold and silver coins, the fractions to be paid in silver.

9. *Regulations which the Principles of this Inquiry point out as expedient to be made by a new Statute for regulating the British Coin.*

8. That in buying and selling, when no particular species has been stipulated, and when no act in writing has intervened, the option of the species shall be competent to the buyer.

LET us now examine what regulations it may be proper to make by a new statute concerning the coin of Great Britain, in order to preserve always the same exact value of the pound Sterling realized in gold and in silver, in spite of all the incapacities inherent in the metals to perform the functions of an invariable scale or measure of value.

9. That all sums paid or received by the king's receivers, or by bankers, shall be delivered by weight, if demanded.

1. The first point is to determine the exact number of grains of fine gold and fine silver which are to compose it, according to the then proportion of the metals in the London market.

10. That all money which shall be found under the legal weight, from whatever cause it may proceed, may be rejected in every payment whatsoever; or if offered in payment of a debt above a certain sum, may be taken according to its weight, at the then mint price, in the option of the creditor.

2. To determine the proportion of these metals with the pound troy; and in regard that the standard of gold and silver is different, let the mint price of both metals be regulated according to the pound troy fine.

11. That no penalty shall be incurred by those who melt down or export the nation's coin; but that washing, clipping, or diminishing the weight of any part of it shall be deemed felony, as much as any other theft, if the person so degrading the coin shall afterwards make it circulate for lawful money.

3. To fix the mint-price within certain limits; that is to say, to leave to the king and council, by proclamation, to carry the mint price of bullion up to the value of the coin, as is the present regulation, or to sink it to *per cent.* below that price, according as government shall incline to impose a duty upon coinage.

To prevent the inconveniences proceeding from the variation in the proportion between the metals, it may be provided,

4. To order, that silver and gold coin shall be struck of such denominations as the king shall think fit to appoint; in which the proportion of the metals

12. That upon every variation of proportion in the market-price of the metals, the price of both shall be changed, according to the following rule:

Let the price of the pound troy fine gold in the coin be called G.

Let the price of ditto in the silver be called S.

Let the new proportion between the market-price of the metals be called P.

Then state this formula;

$$\frac{G}{2P} + \frac{S}{2} = \text{to a pound troy fine silver, in Sterling currency.}$$

$$\frac{S}{2} + P + \frac{G}{2} = \text{to a pound troy fine gold, in Sterl. currency.}$$

This will be a rule for the mint to keep the price of the metals constantly at par with the price of the market; and coinage may be imposed, as has been described, by fixing the mint price of them at a certain rate below the value of the fine metals in the coin.

13. As long as the variation of the market-price of the metals shall not carry the price of the rising metal so high as the advanced price of the coin above the bullion, no alteration need be made on the denomination of either species.

14. So soon as the variation of the market price of the metals shall give a value to the rising species, above the difference between the coin and the bullion; then the king shall alter the denominations of all the coin, silver and gold, adding to the coins of the rising metal exactly what is taken from those of the other. An example will make this plain:

Let us suppose that the coinage has been made according to the proportion of 14.5 to 1; that 20 shillings, or 4 crown-pieces, shall contain, in fine silver, 14.5 times as many grains as the guinea, or the gold pound, shall contain grains of fine gold. Let the new proportion of the metals be supposed to be 14 to 1. In that case, the 20 shillings, or the 4 crowns, will contain  $\frac{1}{8}$  more value than the guinea. Now since there is no question of making a new general coinage upon every variation, in order to adjust the proportion of the metals in the weight of the coins, that proportion must be adjusted by changing their respective denominations according to this formula:

Let the 20 shillings, or 4 crowns, in coin, be called *S*. Let the guinea be called *G*. Let the difference between the old proportion and the new, which is  $\frac{1}{8}$ , be called *P*. Then say,

$$S - \frac{P}{2} = \text{a pound sterling, and } G + \frac{P}{2} = \text{a pound sterl.}$$

By this it appears that all the silver coin must be raised in its denomination  $\frac{1}{8}$ , and all the gold coin must be lowered in its denomination  $\frac{1}{8}$ ; yet still *S*+*G* will be equal to two pounds Sterling, as before, whether they be considered according to the old or according to the new denominations.

But it may be observed, that the imposition of coinage rendering the value of the coin greater than the value of the bullion, that circumstance gives a certain latitude in fixing the new denominations of the coin, so as to avoid minute fractions. For, providing the deviation from the exact proportion shall fall within the advanced price of the coin, no advantage can be taken by melting down one species preferably to another; since, in either case, the loss incurred by melting the coin must be greater than the profit made upon selling the bullion. The mint price of the metals, however, may be fixed exactly, that is, within the value of a farthing upon a pound of fine silver or gold. This is easily reckoned at the mint; although upon every piece in common circulation the fractions of farthings would be inconvenient.

15. That notwithstanding of the temporary variations made upon the denomination of the gold and silver coins, all contracts formally entered into, and all stipulations in pounds shillings and pence, may continue to be acquitted according to the old denominations of the coins, paying one-half in gold, and one-half in silver: unless in the case where a particular species has been stipulated; in which case, the sums must be paid according to the new regulation made upon the denomination of that species, to the end that neither profit or loss may result to any of the parties.

16. That notwithstanding the alterations on the mint price of the metals, and in the denomination of the coins, no change shall be made upon the weight of the particular pieces of the latter, except in the

case of a general re-coinage of one denomination at least: that is to say, the mint must not coin new guineas, crowns, &c. of a different weight from those already in currency, although by so doing the fractions might be avoided. This would occasion confusion, and the remedy would cease to be of any use upon a new change in the proportion of the metals. But it may be found convenient, for removing the small fractions in shillings and sixpences, to recoin such denominations all together, and to put them to their integer numbers, of twelve and of six pence, without changing in any respect their proportion of value to all other denominations of the coin: this will be no great expence, when the bulk of the silver coin is put into 5 shilling pieces.

By this method of changing the denominations of the coin, there never can result any alteration in the value of the pound Sterling; and although fractions of value may now and then be introduced, in order to prevent the abuses to which the coin would otherwise be exposed by the artifice of those who melt it down, yet still the inconvenience of such fractions may be avoided in paying, according to the old denominations, in both species, by equal parts. This will also prove demonstratively, that no change is thereby made in the true value of the national unit of money.

17. That it be ordered, that shillings and sixpences shall only be current for 20 years; and all other coins, both gold and silver, for 40 years, or more. For ascertaining which term, there may be marked, upon the exergue of the coin, the last year of their currency, in place of the date of their fabrication. This term elapsed, or the date effaced, that they shall have no more currency whatsoever; and, when offered in payment, may be received as bullion at the actual price of the mint, or refused, at the option of the creditor.

18. That no foreign coin shall have any legal currency, except as bullion at the mint price.

By these and the like regulations may be prevented, 1<sup>mo</sup>, The melting or exporting of the coin in general. 2<sup>do</sup>, The melting or exporting one species, in order to sell it as bullion at an advanced price. 3<sup>do</sup>, The profit in acquitting obligations preferably in one species to another. 4<sup>to</sup>, The degradation of the standard, by the wearing of the coin, or by a change in the proportion between the metals. 5<sup>to</sup>, The circulation of the coin below the legal weight. 6<sup>to</sup>, The profit that other nations reap by paying their debts more cheaply to Great Britain than Great Britain can pay her's to them.

And the great advantage of it is, that it is an uniform plan, and may serve as a perpetual regulation, compatible with all kinds of denominations of coins, variations in the proportion of the metals, and with the imposition of a duty upon coinage, or with the preserving it free; and further, that it may in time be adopted by other nations, who will find the advantage of having their money of account preserved perpetually at the same value, with respect to the denominations of all foreign money of account established on the same principles.



# A T A B L E OF COINS,

## Showing the Quantity of Fine Metal contained in them.

The number of grains of fine metal in every coin is fought for in the regulations of the mint of the country where it is coined, and is expressed in the grains in tite in that mint. From that weight it is converted into thole of other countries according to the following proportions:  
 3840 Troy grains, 4976.35 Paris grains, 5192.8 Holland aces or grains, and 4640.06 Colonia grains, are supposed to be equal weights; and the coins in the Table are converted according to thole proportions.

TABLE OF COINS, reduced to Grains of fine Metal, according to the  
 Troy, Paris, Colonia, and Holland weights.

GOLD COINS.

SILVER COINS.

		GOLD COINS.					SILVER COINS.				
		Troy.	Paris.	Colonia.	Holland.	Troy.	Paris.	Colonia.	Holland.		
English Coins.	1 A Guinea by fiatue	118651	14446	14305	16045	429.68	523.2	520.2	581.		
	2 A Crown by fiatue	—	—	—	—	85.985	104.65	104.	116.2		
	3 A Shilling by fiatue	—	—	—	—	1718.7	2093.	2080.8	2324.1		
	4 A Silver Pound Sterling by fiatue 1601	—	—	—	—	—	—	—	—		
	5 A Gold Pound Sterling by fiatue 1728	113.	137.61	136.8	152.8	1659.38	1096.4	1984.7	2216.		
	6 A Silver Pound Sterling in currency = $\frac{25}{16}$ lb. Troy	113.	137.61	136.8	152.8	1659.38	1096.4	1984.7	2215.7		
	7 A Silver Pound Sterling, at the proportion of gold to silver as 110 to 14 $\frac{1}{2}$	118.4	144.18	143.34	160.11	1738.7	2093.	2080.8	2324.1		
	8 A Gold Pound Sterling, at the proportion of gold to silver as 110 to 14 $\frac{1}{2}$	118.4	144.18	143.34	160.11	1738.7	2093.	2080.8	2324.1		
	9 A Gold Pound Sterling at the same proportion in gold and in silver	115.769	140.98	140.16	156.55	1678.6	2044.2	2032.2	2269.9		
	10 A Shilling current = $\frac{1}{4}$ of a pound Troy	—	—	—	—	81.961	99.8	99.	110.82		
	11 A Guinea in silver, or 21 Shillings standard weight	—	—	—	—	1804.6	2197.6	2184.8	2400.3		
	12 A Guinea at the proportion of 1 to 14 $\frac{1}{2}$ worth in silver	5760.	7019.2	6973.5	7789.2	1720.4	2095.1	2082.8	2326.4		
	13 A Pound Troy, or 12 ounces English weight	—	—	—	—	—	—	—	—		
French Coins.	1 A Louis d'or	113.27	137.94	137.13	153.17	409.94	499.22	496.3	544.3		
	2 A Crown of six livres	—	—	—	—	204.97	249.61	248.15	277.1		
	3 A Crown of three ditto	—	—	—	—	68.34	83.23	82.74	92.42		
	4 A livre	—	—	—	—	1659.7	1996.9	1985.2	2217.4		
	5 A Louis d'or, or 24 livres in silver	3783.87	4608.	4581.1	5116.9	3783.87	4608.	4581.1	5116.9		
	6 A Marc of Paris weight, fine gold or silver	—	—	—	—	—	—	—	—		
	7 A Marc of gold coin effective weight, in fine	—	—	—	—	—	—	—	—		
	8 A Marc of silver coin effective weight, in fine	3398.3	4138.5	4114.3	4593.4	3402.3	4143.4	4119.2	4600.9		
German Coins.	1 A Carolin legal weight	115.45	140.6	139.78	156.12	—	—	—	—		
	2 A Ducat of the Empire ditto	—	—	—	—	—	—	—	—		
	3 A Florin of Convention	52.8	64.37	64.	71.48	179.73	218.87	217.6	243.		
	4 A Dollar of Convention	—	—	—	—	269.59	328.31	326.4	364.5		
	5 A Dollar of Exchange, the Carolin = 9 flor. 42 kreutzers	17.85	21.74	21.615	24.14	—	—	—	—		
	6 A Florin current = $\frac{1}{3}$ of a Carolin	10.54	12.84	12.77	14.26	—	—	—	—		
Dutch Coins.	7 A Carolin in silver, at the proportion of 1 to 14 $\frac{1}{2}$	—	—	—	—	1674.	2038.6	2026.8	2263.8		
	1 A Dutch Ducat	51.76	63.	62.67	70.	—	—	—	—		
	2 A Florin in silver	—	—	—	—	148.	180.3	179.2	200.21		

# UNIVERSAL TABLE

Of the present State of the REAL and IMAGINARY MONIES of the World.

† This Mark is prefixed to the Imaginary Money, or Money of Account.

All Fractions in the Value English are Parts of a PENNY.

= This Mark signifies *is, make, or equal to.*

## ENGLAND AND SCOTLAND.

*London, Bristol, Liverpool, &c.  
Edinburgh, Glasgow, Aberdeen, &c.*

		£.	s.	d.
A Farthing	=	0	0	0 $\frac{1}{4}$
2 Farthings	=	0	0	0 $\frac{1}{2}$
2 Halfpence	=	0	0	1
4 Pence	=	0	0	4
6 Pence	=	0	0	6
12 Pence	=	0	1	0
5 Shillings	=	0	5	0
20 Shillings	=	1	0	0
21 Shillings	=	1	1	0

## IRELAND.

*Dublin, Cork, Londonderry, &c.*

A Farthing	=	0	0	0 $\frac{1}{4}$
2 Farthings	=	0	0	0 $\frac{1}{2}$
2 Halfpence	=	0	0	1
6 $\frac{1}{2}$ Pence	=	0	0	6
12 Pence	=	0	0	11 $\frac{1}{2}$
13 Pence	=	0	1	0
65 Pence	=	0	5	0
20 Shillings	=	0	18	5 $\frac{1}{2}$
22 $\frac{1}{2}$ Shillings	=	1	1	0

## FLANDERS AND BRABANT.

*Ghent, Osend, &c. Antwerp, Brussels, &c.*

†A Pening	=	0	0	0 $\frac{1}{8}$
4 Peningsens	=	0	0	0 $\frac{1}{2}$
8 Peningsens	=	0	0	0 $\frac{1}{2}$
2 Grotes	=	0	0	0 $\frac{1}{2}$
6 Petards	=	0	0	5 $\frac{1}{10}$
7 Petards	=	0	0	6 $\frac{1}{10}$
40 Grotes	=	0	1	6
17 $\frac{1}{2}$ Scalins	=	0	9	3
240 Grotes	=	0	9	0

## HOLLAND AND ZEALAND.

*Amsterdam, Rotterdam, Middleburg, Flishing, &c.*

†Pening	=	0	0	0 $\frac{1}{16}$
8 Peningsens	=	0	0	0 $\frac{1}{2}$
2 Grotes	=	0	0	1 $\frac{1}{8}$
6 Stivers	=	0	0	6 $\frac{1}{8}$
20 Stivers	=	0	1	9
50 Stivers	=	0	4	4 $\frac{1}{2}$

## HOLLAND, &c.

		£.	s.	d.
60 Stivers	=	0	5	3
105 Stivers	=	0	9	3
6 Guilders	=	0	10	6

## HAMBURG. *Altona, Lubec, Breymen, &c.*

†A Tryling	=	0	0	0 $\frac{1}{2}$
2 Trylings	=	0	0	0 $\frac{1}{2}$
2 Sexlings	=	0	0	0 $\frac{1}{2}$
12 Fenings	=	0	0	1
16 Shillings	=	0	1	6
2 Marcs	=	0	3	0
3 Marcs	=	0	4	6
6 $\frac{1}{2}$ Marcs	=	0	9	4
120 Shillings	=	0	11	3

## HANOVER. *Lunenburgh, Zell, &c.*

†A Fening	=	0	0	0 $\frac{1}{2}$
3 Fenings	=	0	0	0 $\frac{1}{2}$
8 Fenings	=	0	0	1
12 Fenings	=	0	0	0
8 Grothen	=	0	1	2
16 Grothen	=	0	2	4
24 Grothen	=	0	3	6
32 Grothen	=	0	4	8
4 Guildens	=	0	9	2

## SAXONY AND HOLSTEIN.

*Dresden, Leipzig, &c. Wismar, Keil, &c.*

†An Heller	=	0	0	0
2 Hellers	=	0	0	0 $\frac{1}{2}$
6 Hellers	=	0	0	0
16 Hellers	=	0	0	1
12 Fenings	=	0	0	1
16 Grothen	=	0	2	4
24 Grothen	=	0	3	6
52 Grothen	=	0	4	8
4 Goulds	=	0	9	4

## BRANDENBURGH AND POMERANIA

*Berlin, Potsdam, &c. Stetin, &c.*

†A Denier	=	0	0	0 $\frac{1}{16}$
9 Deniers	=	0	0	0
18 Deniers	=	0	0	0
3 Polchens	=	0	0	0
20 Grothen	=	0	0	9

30 Groth

EUROPE, Northern Parts.

EUROPE, Northern Parts.

GERMANY.

BRANDENBURGH, &c.

		£.	s.	d.
30 Groschen	a Florin	0	1	2
90 Groschen	† a Rix-dollar	0	3	6
108 Groschen	a Albertus	0	4	2
8 Florins	a Ducat	0	9	4

COLOGN, *Mentz, Triers, Liege, Munich, Münster, Paderbourn, &c.*

A Dute		0	0	0
3 Dutes	= a Cruitzer	0	0	0 <sup>1</sup> / <sub>10</sub>
2 Cruitzers	an Albus	0	0	0 <sup>1</sup> / <sub>10</sub>
8 Dutes	a Stiver	0	0	0 <sup>1</sup> / <sub>10</sub>
3 Stivers	a Plapert	0	0	2 <sup>1</sup> / <sub>10</sub>
4 Plaperts	a Copfluck	0	0	8 <sup>1</sup> / <sub>10</sub>
40 Stivers	a Guilder	0	2	4
2 Guilders	a Hard Dollar	0	4	8
4 Guilders	a Ducat	0	9	4

BOHEMIA, SILESIA, AND HUNGARY.

*Prague, Breslau, Presburg, &c.*

A Fening		0	0	0
2 Fenings	= a Dreyer	0	0	0 <sup>1</sup> / <sub>10</sub>
3 Fenings	a Grosh	0	0	0 <sup>1</sup> / <sub>10</sub>
4 Fenings	a Cruitzer	0	0	0 <sup>1</sup> / <sub>10</sub>
2 Cruitzers	a White Grosh	0	0	0 <sup>1</sup> / <sub>10</sub>
60 Cruitzers	a Gould	0	2	4
90 Cruitzers	† a Rix-dollar	0	3	6
2 Goulds	a Hard Dollar	0	4	8
4 Goulds	a Ducat	0	9	4

AUSTRIA AND SWABIA.

*Vienna, Tiesse, &c. Aufburg, Blenheim, &c.*

A Fening		0	0	0
2 Fenings	= a Dreyer	0	0	0 <sup>1</sup> / <sub>10</sub>
4 Fenings	a Cruitzer	0	0	0 <sup>1</sup> / <sub>10</sub>
14 Fenings	a Grosh	0	0	1 <sup>1</sup> / <sub>10</sub>
4 Cruitzers	a Batzen	0	0	1 <sup>1</sup> / <sub>10</sub>
15 Batzen	a Gould	0	2	4
90 Cruitzers	† a Rix-dollar	0	3	6
30 Batzen	a Specie-dollar.	0	4	8
60 Batzen	a Ducat	0	9	4

FRANCONIA, *Frankfort, Nuremburg, Dettingen, &c.*

A Fening		0	0	0
4 Fenings	= a Cruitzer	0	0	0 <sup>1</sup> / <sub>10</sub>
3 Cruitzers	a Keyser Grosh	0	0	1 <sup>1</sup> / <sub>10</sub>
4 Cruitzers	a Batzen	0	0	1 <sup>1</sup> / <sub>10</sub>
15 Cruitzers	an Ort Gould	0	0	7
60 Cruitzers	a Gould	0	2	4
90 Cruitzers	† a Rix-dollar	0	3	6
2 Goulds	a Hard Dollar	0	4	8
240 Cruitzers	a Ducat	0	9	4

POLAND AND PRUSSIA.

*Cracow, Warsaw, &c. Dantzic, Koningsberg, &c.*

A Shelon		0	0	0
3 Shelons	= a Grosh	0	0	0 <sup>1</sup> / <sub>10</sub>
5 Groshen	a Couffic	0	0	2 <sup>1</sup> / <sub>10</sub>
3 Couffics	a Tinf	0	0	7

POLAND, &c.

		£.	s.	d.
18 Groschen	an Ort	0	0	8 <sup>1</sup> / <sub>10</sub>
30 Groschen	a Florin	0	1	2
90 Groschen	† a Rix-dollar	0	3	6
8 Florins	a Ducat	0	9	4
5 Rix-dollars	a Frederic d'Or	0	17	6

LIVONIA.

*Riga, Revel, Narva, &c.*

A Blacken		0	0	0
6 Blackens	= a Grosh	0	0	0 <sup>1</sup> / <sub>10</sub>
9 Blackens	a Vording	0	0	0 <sup>1</sup> / <sub>10</sub>
2 Groshen	a Whiten	0	0	0 <sup>1</sup> / <sub>10</sub>
6 Groshen	a Marc	0	0	2 <sup>1</sup> / <sub>10</sub>
30 Groshen	a Florin	0	1	2
90 Groshen	† a Rix-dollar	0	3	6
108 Groshen	an Albertus	0	4	2 <sup>1</sup> / <sub>10</sub>
64 Whitens	a Copper-plate Dollar	0	5	0

DENMARK, ZEA LAND, AND NORWAY.

*Copenhagen, Sound, &c. Bergen, Drontheim, &c.*

A Skilling		0	0	0
6 Skillings	= a Duggen	0	0	0 <sup>1</sup> / <sub>10</sub>
16 Skillings	† a Marc	0	0	3 <sup>1</sup> / <sub>10</sub>
20 Skillings	a Rix-marc	0	0	9
24 Skillings	a Rix-ort	0	1	1 <sup>1</sup> / <sub>10</sub>
4 Marcs	a Crown	0	3	0
6 Marcs	a Rix-dollar	0	4	6
11 Marcs	a Ducat	0	8	3
14 Marcs	a Hart Ducat	0	10	6

SWEDEN AND LAPLAND.

*Stockholm, Upsal, &c. Thorn, &c.*

† A Runftick		0	0	0
2 Runfticks	= a Stiver	0	0	0 <sup>1</sup> / <sub>10</sub>
8 Runfticks	a Copper Marc	0	0	1 <sup>1</sup> / <sub>10</sub>
3 Copper Marcs	a Silver Marc	0	0	4 <sup>1</sup> / <sub>10</sub>
4 Copper Marcs	a Copper Dollar	0	0	6 <sup>1</sup> / <sub>10</sub>
9 Copper Marcs	a Caroline	0	1	2
3 Copper Dollars	a Silver Dollar	0	1	6 <sup>1</sup> / <sub>10</sub>
3 Silver Dollars	a Rix-dollar	0	4	8
2 Rix-dollars	a Ducat	0	9	4

RUSSIA AND MUSCOVY.

*Petersburg, Archangel, &c. Moscow, &c.*

A Polufca		0	0	0
2 Polufcas	= a Denufca	0	0	0 <sup>1</sup> / <sub>10</sub>
2 Denufcas	† a Copec	0	0	0 <sup>1</sup> / <sub>10</sub>
3 Copecs	an Altin	0	0	1 <sup>1</sup> / <sub>10</sub>
10 Copecs	a Grievener	0	0	5 <sup>1</sup> / <sub>10</sub>
25 Copecs	a Polpotin	0	1	1 <sup>1</sup> / <sub>10</sub>
50 Copecs	a Poltin	0	2	3
100 Copecs	a Ruble	0	4	6
2 Rubles	a Xervonitz	0	9	0

BASIL. *Zurick, Zug, &c.*

A Rap		0	0	0
3 Rapen	= a Fening	0	0	0 <sup>1</sup> / <sub>10</sub>
4 Fenings	a Cruitzer	0	0	0 <sup>1</sup> / <sub>10</sub>
12 Fenings	† a Sol	0	0	1 <sup>1</sup> / <sub>10</sub>

EUROPE, Northern Parts.  
GERMANY.

EUROPE, Northern Parts.

		£.	s.	d.
15 Fenings	= a Coarfe Batzen	0	0	1
18 Fenings	a Good Batzen	0	0	2
20 Sols	† a Livre	0	2	6
60 Cruitzers	a Gulden	0	2	6
108 Cruitzers	a Rix-dollar	0	4	6

ST GALL. Appenzel, &c.

An Heller	=	0	0	0
2 Hellers	a Fening	0	0	0
4 Fenings	a Cruitzer	0	0	0
12 Fenings	† a Sol	0	0	1
4 Cruitzers	a Coarfe Batzen	0	0	2
5 Cruitzers	a Good Batzen	0	0	2
20 Sols	† a Livre	0	2	6
60 Cruitzers	a Guld	0	2	6
102 Cruitzers	a Rix-dollar	0	4	3

BERN. Lucern, Neufchatel, &c.

A Denier	=	0	0	0
4 Deniers	a Cruitzer	0	0	0
3 Cruitzers	† a Sol	0	0	1
4 Cruitzers	a Plapert	0	0	1
5 Cruitzers	a Gros	0	0	2
6 Cruitzers	a Batzen	0	0	2
20 Sols	† a Livre	0	2	6
75 Cruitzers	a Gulden	0	2	6
135 Cruitzers	a Crown	0	4	6

GENEVA. Pekay, Bonne, &c.

A Denier	=	0	0	0
2 Deniers	a Denier current	0	0	0
12 Deniers	a Small Sol	0	0	0
12 Deniers current	a Sol current	0	0	0
12 Small Sols	† a Florin	0	0	4
20 Sols current	† a Livre current	0	1	3
10½ Florins	a Patacon	0	3	11
15½ Florins	a Croifade	0	5	10
24 Florins	a Ducat	0	9	0

Lijfe, Cambray, Valenciennes, &c.

A Denier	=	0	0	0
12 Deniers	a Sol	0	0	0
15 Deniers	† a Patard	0	0	0
15 Patards	† a Piette	0	0	9
20 Sols	a Livre Tournois	0	10	0
20 Patards	† a Florin	0	1	0
60 Sols	an Ecu of Ex.	0	2	6
10½ Livres	a Ducat	0	9	3
24 Livres	a Lois d'Or	1	0	0

Dunkirk, St Omers, St Quintin, &c.

A Denier	=	0	0	0
12 Deniers	a Sol	0	0	0
15 Deniers	† a Patard	0	0	0
15 Sols	† a Piette	0	0	7
20 Sols	† a Livre Tournois	0	10	0
3 Livres	an Ecu of Ex.	0	2	6
24 Livres	a Lois d'Or	1	0	0
24 Livres	a Guinea	1	1	0
30½ Livres	a Moeda	1	7	0

A Denier	=	0	0	0
3 Deniers	a Liard	0	0	0
2 Liards	a Dardenc	0	0	0
12 Deniers	a Sol	0	0	0
20 Sols	† a Livre Tournois	0	10	0
60 Sols	an Ecu of Ex.	0	2	6
6 Livres	an Ecu	0	5	0
10 Livres	† a Pistole	0	8	4
24 Livres	a Louis d'Or	1	0	0

PORTUGAL. Lisbon, Oporto, &c.

† A Re	=	0	0	0
10 Rez	a Half Vintin	0	0	0
20 Rez	a Vintin	0	0	1
5 Vintins	a Testoon	0	0	6
4 Testoons	a Crufade of Ex.	0	2	3
24 Vintins	a New Crufade	0	2	8
10 Testoons	† a Milre	0	5	7
48 Testoons	a Moeda	1	7	0
64 Testoons	a Joanece	1	16	0

Madrid, Cadiz, Seville, &c. New Plate.

A Maravedie	=	0	0	0
2 Maravedies	a Quartil	0	0	0
34 Maravedies	a Rial	0	0	5
2 Rials	a Pittarine	0	0	10
8 Rials	† a Piaitre of Ex.	0	3	7
10 Rials	a Dollar	0	4	6
375 Maravedius	† a Ducat of Ex.	0	4	11
32 Rials	† a Pistole of Ex.	0	14	4
36 Rials	a Pistole	0	16	9

Gibraltar, Malaga, Denia, &c. Velon.

† A Maravedie	=	0	0	0
2 Maravedies	a Ochavo	0	0	0
4 Maravedies	a Quartil	0	0	0
34 Maravedies	† a Rial Velon	0	0	2
15 Rials	† a Piaitre of Ex.	0	3	7
512 Maravedies	a Piaitre	0	3	7
60 Rials	† a Pistole of Ex.	0	14	4
2048 Maravedies	a Pistole of Ex.	0	16	9
78 Rials	a Pistole	0	16	9

Barcelona, Saragossa, Valencia, &c. Old Plate.

A Maravedie	=	0	0	0
16 Maravedies	a Soldo	0	0	3
2 Soldos	a Rial Old Plate	0	0	6
20 Soldos	† a Libra	0	5	7
24 Soldos	† a Ducat	0	6	9
16 Soldos	† a Dollar	0	4	6
22 Soldos	† a Ducat	0	6	2
21 Soldos	† a Ducat	0	5	10
60 Soldos	a Pistole	0	16	9

GENOA. Novi, &c. CORSICA. Bastia, &c.

A Denari	=	0	0	0
12 Denari	a Soldi	0	0	0
4 Soldi	a Chevalet	0	1	1
20 Soldi	† a Lire	0	0	8
30 Soldi	a Testoon	0	1	0

5 Livres

EUROPE, Southern Parts. SWITZERLAND. EUROPE, Southern Parts. SPAIN and CATALONIA. FRANCE and NAVARRE.

EUROPE, Southern Parts. SPAIN and CATALONIA. ITALY.

M O N  
GENOA, &c.

[ 5079 ]

M O N

SICILY AND MALTA. Palermo, Messina, &c.

		£.	s.	d.
5 Lires	=	a Croifade	0	3 7
115 Soldi	†a	Pezzo of Ex.	0	4 2
6 Testoons		a Genuine	0	6 2
20 Lires		a Pistole	0	14 4

		£.	s.	d.
A Pichila	-	-	0	0 1 <sup>1</sup> / <sub>2</sub>
6 Pichili	=	a Grain	0	0 0 <sup>1</sup> / <sub>2</sub>
8 Pichili		a Ponti	0	0 0 <sup>1</sup> / <sub>2</sub>
10 Grains		a Carlin	0	0 1 <sup>1</sup> / <sub>2</sub>
20 Grains		a Tarin	0	0 3 <sup>1</sup> / <sub>2</sub>
6 Tarins	†a	Florin of Ex.	0	1 0 <sup>1</sup> / <sub>2</sub>
13 Tarins		a Ducat of Ex.	0	3 4
60 Carlins	†an	Ounce	0	7 8 <sup>1</sup> / <sub>2</sub>
2 Ounces		a Pistole	0	15 4

PIEDMONT, SAVOY, AND SARDINIA.

Turin, Chamberry, Cagliari, &c.

			£.	s.	d.
A Denari	-	-	0	0	0 1 <sup>1</sup> / <sub>2</sub>
3 Denari	=	a Quatrini	0	0	0 1 <sup>1</sup> / <sub>2</sub>
12 Denari		a Soldi	0	0	0 6 <sup>1</sup> / <sub>2</sub>
12 Soldi	†a	Florin	0	0	9 0
20 Soldi	†a	Lire	0	1	3 0
6 Florins		a Scudi	0	4	6 0
7 Florins		a Ducatoon	0	5	3 0
13 Lires		a Pistole	0	16	3 0
16 Lires		a Louis d'Or	1	0	0 0

Milan, Modena, Parma, Pavia, &c.

			£.	s.	d.
A Denari	-	-	0	0	0 1 <sup>1</sup> / <sub>2</sub>
3 Denari	=	a Quatrini	0	0	0 1 <sup>1</sup> / <sub>2</sub>
12 Denari		a Soldi	0	0	0 6 <sup>1</sup> / <sub>2</sub>
20 Soldi	†a	Lire	0	0	8 1 <sup>1</sup> / <sub>2</sub>
115 Soldi		a Scudi current	0	4	2 1 <sup>1</sup> / <sub>2</sub>
117 Soldi	†a	Scudi of Ex.	0	4	3 1 <sup>1</sup> / <sub>2</sub>
6 Lires		a Philip	0	4	4 1 <sup>1</sup> / <sub>2</sub>
22 Lires		a Pistole	0	16	0 0
23 Lires		a Spanish Pistole	0	16	9 0

Laghorn, Florence, &c.

			£.	s.	d.
A Denari	-	-	0	0	0 1 <sup>1</sup> / <sub>2</sub>
4 Denari	=	a Quatrini	0	0	0 1 <sup>1</sup> / <sub>2</sub>
12 Denari		a Soldi	0	0	0 6 <sup>1</sup> / <sub>2</sub>
5 Quatrini		a Craca	0	0	0 0 1 <sup>1</sup> / <sub>2</sub>
8 Craças		a Quilo	0	0	5 0 1 <sup>1</sup> / <sub>2</sub>
20 Soldi	†a	Lire	0	0	8 1 <sup>1</sup> / <sub>2</sub>
6 Lires		a Piaſtre of Ex.	0	4	2 1 <sup>1</sup> / <sub>2</sub>
7 1/2 Lires		a Ducat	0	5	2 1 <sup>1</sup> / <sub>2</sub>
22 Lires		a Pistole	0	15	6 1 <sup>1</sup> / <sub>2</sub>

ROME, Civita, Vecchia, Ancona.

			£.	s.	d.
A Quatrini	-	-	0	0	0 1 <sup>1</sup> / <sub>2</sub>
5 Quatrini	=	a Bayoc	0	0	0 1 <sup>1</sup> / <sub>2</sub>
8 Bayocs		a Julio	0	0	6 1 <sup>1</sup> / <sub>2</sub>
10 Bayocs		a Stamp Julio	0	0	7 1 <sup>1</sup> / <sub>2</sub>
24 Bayocs		a Teftoon	0	1	6 1 <sup>1</sup> / <sub>2</sub>
10 Julios		a Crown current	0	5	0 0
12 Julios	†a	Crown ſtamp	0	6	0 0
18 Julios		a Chequin	0	9	0 0
31 Julios		a Piſtole	0	15	6 0

NAPLES. Gaſta, Capua, &c.

			£.	s.	d.
A quatrini	-	-	0	0	0 1 <sup>1</sup> / <sub>2</sub>
3 Quatrini	=	a Grain	0	0	0 1 <sup>1</sup> / <sub>2</sub>
10 Grains		a Carlin	0	0	4 1 <sup>1</sup> / <sub>2</sub>
40 Quatrini		a Paulo	0	0	5 1 <sup>1</sup> / <sub>2</sub>
20 Grains		a Tarin	0	0	8 1 <sup>1</sup> / <sub>2</sub>
40 Grains		a Teftoon	0	1	4 1 <sup>1</sup> / <sub>2</sub>
100 Grains		a Ducat of Ex.	0	3	4 1 <sup>1</sup> / <sub>2</sub>
23 Tarins		a Piſtole	0	15	4 1 <sup>1</sup> / <sub>2</sub>
25 Tarins		a Spaniſt Piſtole	1	16	9 1 <sup>1</sup> / <sub>2</sub>

EUROPE, Southern Parts.

ITALY.

Bologna, Ravenna, &c.

			£.	s.	d.
A Quatrini	-	-	0	0	0 1 <sup>1</sup> / <sub>2</sub>
6 Quatrini	=	a Bayoc	0	0	0 6 <sup>1</sup> / <sub>2</sub>
10 Bayocs	†a	Julio	0	0	0 6 1 <sup>1</sup> / <sub>2</sub>
20 Bayocs		a Lire	0	1	0 0
3 Julios		a Teftoon	0	1	6 1 <sup>1</sup> / <sub>2</sub>
80 Bayocs		a Scudi of Ex.	0	4	3 1 <sup>1</sup> / <sub>2</sub>
105 Bayocs		a Ducatoon	0	5	3 1 <sup>1</sup> / <sub>2</sub>
100 Bayocs		a Crown	0	5	0 0
31 Julios		a Piſtole	0	15	6 1 <sup>1</sup> / <sub>2</sub>

VENICE. Bergamo, &c.

			£.	s.	d.
A Picoli	-	-	0	0	0 1 <sup>1</sup> / <sub>2</sub>
12 Picoli	=	a Soldi	0	0	0 1 <sup>1</sup> / <sub>2</sub>
6 1/2 Soldi	†a	Gros	0	0	2 1 <sup>1</sup> / <sub>2</sub>
18 Soldi		a Jule	0	0	6 1 <sup>1</sup> / <sub>2</sub>
20 Soldi	†a	Lire	0	0	6 1 <sup>1</sup> / <sub>2</sub>
3 Julcs		a Teftoon	0	1	6 1 <sup>1</sup> / <sub>2</sub>
124 Soldi		a Ducat current	0	3	5 1 <sup>1</sup> / <sub>2</sub>
24 Gros	†a	Ducat of Ex.	0	4	4 1 <sup>1</sup> / <sub>2</sub>
17 Lires		a Chequin	0	9	2 1 <sup>1</sup> / <sub>2</sub>

TURKEY. Morea, Candia, Cyprus, &c.

			£.	s.	d.
A Mangar	-	-	0	0	0 3 <sup>1</sup> / <sub>2</sub>
4 Mangars	=	†an Aſper	0	0	0 0 1 <sup>1</sup> / <sub>2</sub>
3 Aſpers		a Parac	0	0	1 1 <sup>1</sup> / <sub>2</sub>
5 Aſpers		a Belic	0	0	3 1 <sup>1</sup> / <sub>2</sub>
10 Aſpers		an Oilic	0	0	6 1 <sup>1</sup> / <sub>2</sub>
20 Aſpers		a Solota	0	1	0 0
80 Aſpers	†a	Piaſtre	0	4	0 0
100 Aſpers		a Caragrouch	0	5	0 0
10 Solotas		a Xeriff	0	10	0 0

ARABIA. Medina, Mecca, Mocha, &c.

			£.	s.	d.
A Carret	-	-	0	0	0 1 <sup>1</sup> / <sub>2</sub>
5 1/2 Carrets	=	a Caver	0	0	0 1 <sup>1</sup> / <sub>2</sub>
7 Carreta		a Comafhee	0	0	0 1 <sup>1</sup> / <sub>2</sub>
80 Carrets		a Larin	0	0	10 1 <sup>1</sup> / <sub>2</sub>
18 Comafhees		an Abyſ	0	1	4 1 <sup>1</sup> / <sub>2</sub>
60 Comafhees	†a	Piaſtre	0	4	6 1 <sup>1</sup> / <sub>2</sub>
80 Cavers		a Dollar	0	4	6 1 <sup>1</sup> / <sub>2</sub>
100 Comafhees		a Sequin	0	7	6 1 <sup>1</sup> / <sub>2</sub>
80 Larins	†a	Tomond	3	7	6 1 <sup>1</sup> / <sub>2</sub>

PERSIA. Iſſahan, Ormus, Gombroon, &c.

			£.	s.	d.
A Coz	-	-	0	0	0 1 <sup>1</sup> / <sub>2</sub>
4 Coz	=	a Biſi	0	0	1 1 <sup>1</sup> / <sub>2</sub>
10 Coz		a Shahee	0	0	4 1 <sup>1</sup> / <sub>2</sub>
20 Coz		a Mamooda	0	0	8 1 <sup>1</sup> / <sub>2</sub>
25 Coz		a Larin	0	0	10 1 <sup>1</sup> / <sub>2</sub>
4 Shahees		an Abaſhee	0	1	4 1 <sup>1</sup> / <sub>2</sub>

5 Abaſhees

EUROPE, Southern Parts.

ITALY.

ASIA.

5 Abafhees	=	an Or	-	-	£. s. d.
12 Abafhees		a Bovello	-	-	0 8 6
50 Abafhees		† a Tonond	-	-	0 16 0
					3 6 8

GUZZURAT. *Surat, Cambay, &c.*

A Pecka	-	-	0 0	0 1/2
2 Peckas	=	a Pice	-	0 0 0 1/2
4 Pices		a Fanam	-	0 0 1 1/2
5 Pices		a Viz	-	0 0 2 1/2
10 Pices		an Ana	-	0 0 7 1/2
4 Anas		a Rupee	-	0 2 6
2 Rupees		an English Crown	-	0 5 0
14 Anas		a Pagoda	-	0 8 9
4 Pagodas		a Gold Rupee	-	1 15 0

*Bombay, Dabul, &c.*

† A Budgrook	-	-	0 0	0 1/2
2 Budgrooks	=	† a Re	-	0 0 0 1/2
5 Rez		a Pice	-	0 0 0 1/2
16 Pices		a Laree	-	0 0 5 1/2
20 Pices		a Quarter	-	0 0 6 1/2
240 Rez		a Xeraphim	-	0 1 4 1/2
4 Quarters		a Rupee	-	0 2 3
14 Quarters		a Pagoda	-	0 8 0
60 Quarters		a Gold Rupee	-	1 15 0

*Goa, Vijapur, &c.*

† A Re	-	-	0 0	0 1/2
2 Rez	=	a Bazaraco	-	0 0 0 1/2
2 Bazaracos		a Pecka	-	0 0 0 1/2
20 Rez		a Vintin	-	0 0 1 1/2
4 Vintins		a Laree	-	0 0 5 1/2
3 Larees		a Xeraphim	-	0 1 4 1/2
42 Vintins		a Tangu	-	0 4 6
4 Tangus		a Paru	-	0 18 0
8 Tangus		a Gold Rupee	-	1 15 0

COROMANDEL. *Madras, Pondicherry, &c.*

A cash	-	-	0 0	0 1/2
5 Cash	=	a Viz	-	0 0 0 1/2
2 Viz		a Pice	-	0 0 0 0
6 Pices		a Pical	-	0 0 2 1/2
8 Pices		a Fanam	-	0 0 3
10 Fanams		a Rupee	-	0 2 6
2 Rupees		an English Crown	-	0 5 0
35 Fanams		a Pagoda	-	0 8 9
4 Pagodas		a Gold Rupee	-	1 15 0

BENGAL. *Calicut, Calcutta, &c.*

A Pice	-	-	0 0	0 1/2
4 Pices	=	a Fanam	-	0 0 0 1/2
6 Pices		a Viz	-	0 0 0 1/2
12 Pices		an Ana	-	0 0 1 1/2
10 Anas		a Fiano	-	0 1 6 1/2
16 Anas		a Rupee	-	0 2 6
2 Rupees		a French Ecu	-	0 5 0
2 Rupees		an English Crown	-	0 5 0
56 Anas		a Pagoda	-	0 8 9

SIAM. *Pegu, Malacca, Cambodia, Sumatra, Java, Borneo, &c.*

A Cori	-	-	0 0	0 1/2
800 Cori	=	a Fettee	-	0 0 0 1/2
125 Fettees		a Sateleer	-	0 0 7 1/2
250 Fettees		a Sooco	-	0 1 3
500 Fettees		a Tatal	-	0 2 6
900 Fettees		a Dollar	-	0 4 6
2 Ticals		a Rial	-	0 5 0
4 Soocos		an Ecu	-	0 5 0
8 Sateleers		a Crown	-	0 5 0

CHINA. *Pekin, Canton, &c.*

A Caxa	-	-	0 0	0 1/2
10 Caxa	=	a Candereen	-	0 0 0 1/2
10 Candereens		a Mace	-	0 0 8
35 Candereens		a Rupee	-	0 2 6
2 Rupes		a Dollar	-	0 4 6
70 Candereens		a Rix-dollar	-	0 4 4 1/2
7 Maces		an Ecu	-	0 5 0
2 Rupees		a Crown	-	0 5 0
10 Maces		† a Tale	-	0 6 8

JAPAN. *Jedda, Meaco, &c.*

A Piti	-	-	0 0	0 1/2
20 Pitis	=	a Mace	-	0 0 4
15 Maces		an Ounce Silver	-	0 4 10 1/2
20 Maces		a Tale	-	0 6 8
30 Maces		an Ingot	-	0 9 8 1/2
13 Ounces Silver		an Ounce Gold	-	3 3 0
2 Ounces Gold		a Japanese	-	6 6 0
2 Japanese		a Double	-	12 12 0
21 Ounces Gold		† a Cattee	-	66 3 0

EGYPT. *Old and New Cairo, Alexandria, Sayde, &c.*

An Asper	-	-	0 0	0 1/2
3 Aspers	=	a Medin	-	0 0 1 1/2
24 Medins		an Italian Ducat	-	0 3 4
80 Aspers		† a Piaftre	-	0 4 0
30 Medins		a Dollar	-	0 4 6
96 Aspers		an Ecu	-	0 5 0
32 Medins		a Crown	-	0 5 0
200 Aspers		a Sultanin	-	0 10 0
70 Medins		a Pargo Dollar	-	0 10 6

BARBARY. *Algiers, Tunis, Tripoli, Una, &c.*

An Asper	-	-	0 0	0 1/2
3 Aspers	=	a Medin	-	0 0 1 1/2
10 Aspers		a Rial old Plate	-	0 0 6 1/2
2 Rials		a Double	-	0 1 1 1/2
4 Doubles		a Dollar	-	0 4 6
24 Medins		a Silver Chequin	-	0 3 4
30 Medins		a Dollar	-	0 4 6
180 Aspers		a Zequin	-	0 8 10
15 Doubles		a Pitoole	-	0 16 9

MOROCCO. *Santa Cruz, Mequinez, Fez, Tangiers, Salice, &c.*

A Fluce	-	-	0 0	0 1/2
24 Fluces	=	a Blanquil	-	0 0 2

ASIA.

MOOR.

MALABAR.

ASIA.

AFRICA.

MON  
MOROCCO, &c.

[ 5181 ]

MON  
ENGLISH. Nova Scotia, Virginia, New Eng-  
land, &c.

AFRICA.

			£.	s.	d.
4	Blanquils	= an Ounce	0	0	8
7	Blanquils	an O&avo	0	1	2
14	Blanquils	a Quarto	0	2	4
2	Quartos	a Medio	0	4	8
28	Blanquils	a Dollar	0	4	6
54	Blanquils	a Xequin	0	9	0
100	Blanquils	a Pittole	0	16	9

ENGLISH. Jamaica, Barbadoes, &c.

†	Halfpenny	=	†	a Penny	0	0	0	<sup>1</sup> / <sub>2</sub>
2	Halfpence	=	†	a Penny	0	0	0	<sup>1</sup> / <sub>2</sub>
7½	Pence	=	†	a Bit	0	0	5	<sup>1</sup> / <sub>4</sub>
12	Pence	=	†	a Shilling	0	0	8	<sup>1</sup> / <sub>3</sub>
75	Pence	=	†	a Dollar	0	4	6	<sup>1</sup> / <sub>3</sub>
7	Shillings	=	†	a Crown	0	5	0	<sup>1</sup> / <sub>3</sub>
20	Shillings	=	†	a Pound	0	14	3	<sup>1</sup> / <sub>3</sub>
24	Shillings	=	†	a Pittole	0	16	9	<sup>1</sup> / <sub>3</sub>
30	Shillings	=	†	a Guinea	1	1	0	<sup>1</sup> / <sub>3</sub>

FRENCH. St Domingo, Martinico, &c.

†	A Half Sol	=	†	a Sol	0	0	0	<sup>1</sup> / <sub>2</sub>
2	Half Sols	=	†	a Sol	0	0	0	<sup>1</sup> / <sub>2</sub>
7½	Sols	=	†	a Half Scalin	0	0	2	<sup>1</sup> / <sub>3</sub>
15	Sols	=	†	a Scalin	0	0	5	<sup>1</sup> / <sub>3</sub>
20	Sols	=	†	a Livre	0	0	7	<sup>1</sup> / <sub>3</sub>
7	Livres	=	†	a Dollar	0	4	6	<sup>1</sup> / <sub>3</sub>
8	Livres	=	†	an Ecu	0	4	10	<sup>1</sup> / <sub>3</sub>
26	Livres	=	†	a Pittole	0	16	9	<sup>1</sup> / <sub>3</sub>
32	Livres	=	†	a Louis d'Or	1	0	0	<sup>1</sup> / <sub>3</sub>

			£.	s.	d.		
†	A Penny	=	†	a Shilling	0	0	1
12	Pence	=	†	a Shilling	0	0	1
20	Shillings	=	†	a Pound	1	0	0

The value of the Currency alters according to the Plenty or Scarcity of Gold and Silver Coins that are imported.

AMERICA.

WEST-INDIES.

AMERICA.

CONTINENT.

Canada, Florida, Cayena, &c.

†	A Denier	=	†	a Sol	0	0	0
12	Deniers	=	†	a Sol	0	0	0
20	Sols	=	†	a Livre.	0	0	0
2	Livres						
3	Livres						
4	Livres						
5	Livres						
6	Livres						
7	Livres						
8	Livres						
9	Livres						
10	Livres						

The Value of the Currency alters according to the Plenty or Scarcity of Gold and Silver Coins that are imported.

Note. For all the Spanish, Portuguese, Dutch, and Danish Dominions, either on the Continent or in the West Indies, see the Moneys of the respective nations.

Monk. MONK, a person who wholly dedicates himself to the service of religion, in some monastery, under the direction of particular statutes and rules.

their admission; but they underwent a triennial probation, during which time they were inured to the exercises of the monastic life. If, after that time was expired, they chose to continue the same exercises, they were then admitted, without any farther ceremony, into the community. As the monasteries had no standing revenues, all the monks were obliged to maintain themselves by their daily labour: they had no idle mendicants among them; but looked upon a monk who did not work, as a covetous defrauder. Every ten monks were subject to one, who was called the *decanus*, or *dean*, from his presiding over ten; and every hundred had another officer called *centenarius*, from his presiding over an hundred; and above these were the fathers of the monasteries, also called *abbots*. The business of the deans was to exact every man's daily task, and carry it to the steward, who gave a monthly account of it to the abbot. See ABBOT.

The most probable account of the original of the monks is, that in the Decian persecution, in the middle of the third century, many persons in Egypt, to avoid the fury of the storm, fled to the neighbouring deserts and mountains, where they not only found a safe retreat, but also more time and liberty to exercise themselves in acts of piety and divine contemplations; which sort of life became so agreeable, that, when the persecution was over, they refused to return to their habitations again, choosing rather to continue in those cottages and cells which they had made for themselves in the wildernesses. From that time to the reign of Constantine, monachism was confined to the hermits or anchorites, who lived in private cells in the wildernesses: but when Pachomius had erected MONASTERIES, other countries presently followed the example.

For a particular account of the present monastic orders, see AUGUSTINES, BENEDICTINES, CARMELITES, DOMINICANS, FRANCISCANS, &c.

The manner of admission to the monastic life was usually by some change of habit; not to signify any religious mystery, but only to express their gravity and contempt of the world. Long hair was always thought an indecency in men, and favouring of secular vanity; and therefore they polled every monk at his admission, to distinguish him from seculars; but they never shaved them, lest they should look like the priests of Isis. St Jerom, speaking of the habits of the monks, intimates that it differed from that of others only in this, that it was cheaper, coarser, and meaner raiment. We read of no solemn vow, or profession, required at

Monk. MONK (George), a personage memorable for having been the principal agent in restoring Charles II. to his crown, was descended from a very ancient family, and born in Devonshire in 1608. Being an unprovided younger son, he dedicated himself to arms from his youth, and obtained a pair of colours in the expedition to the Isle of Rhé: he served afterwards in the Low Countries with reputation in both king Charles's northern expeditions; and did such service in quelling the Irish rebellion, that he was appointed governor of

Monk  
↓  
Monks.

Dublin, but was superseded by parliamentary authority. Being made major-general of the Irish brigade employed in the siege of Nantwich in Cheshire, he was taken prisoner by Sir Thomas Fairfax, and remained confined in the tower of London until the year 1646; when, as the means of liberty, he took the Covenant, and accepted a command in the Irish service under the parliament. He obtained the command in chief of all the parliamentary forces in the north of Ireland, where he did signal services, until he was called to account for a treaty made with the Irish rebels; a circumstance which was only obliterated by his future good fortune. He served against Charles II. under Oliver Cromwell with such success, that Oliver left him there as commander in chief; and he was one of the commissioners for uniting that kingdom with the new-erected commonwealth. He served at sea also against the Dutch; and was treated so kindly on his return, that Oliver is said to have grown jealous of him. He was, however, again sent to Scotland as commander in chief, and continued there five years: when he dissembled so well, and improved circumstances so dextrously, that he aided the desires of a wearied people, and restored the king without any disturbance; for which he was immediately rewarded both with honours and profits. See BRITAIN, n° 194, &c.—He was created duke of Albemarle, with a grant of 7000*l.* per annum estate, beside other emoluments; and enjoyed the confidence of his master without forfeiting that of the people. After his death, in 1670, there was published a treatise composed by him while he remained prisoner in the tower, intitled, *Observations on military and political affairs*, a small folio.

MONKEY, in zoology. See APE, and SIMIA.

MONKS-HOOD, or *Wolf's-bane*. See ACONITUM.

Since the time of Theophrastus, most of the species of monks-hood have been reckoned a deadly poison both to men and brutes. Dioscorides, however, recommends the external application of common monks-hood for pains of the eyes. The flowers of a great many species communicate their noxious quality by being smelled to; and those of the species called *nagellus* being placed on the head, occasion a violent megrim. Of the bad qualities of these plants we sometimes avail ourselves to get rid of vermin. A decoction of the roots destroys bugs; the same part being powdered and administered in bread or some other palatable vehicle, to rats and mice, corrodes and inflames their intestines, and soon proves mortal. The juice of the plant is used to poison flesh with, for the destruction of wolves, foxes, and other ravenous beasts. The best antidote to the poison of the different monks-hoods is said to be the root of a species of the same genus, hence termed *healthful* or *wholesome monks-hood*. It is the *aconitum anthora* of Linnæus. The same plant is regarded as efficacious against bites of serpents and other venomous creatures. The roots have a bitter acrid taste; the leaves are only bitter: the former are chiefly used in medicine; and, besides the excellent quality just mentioned, are stomachic, and promote perspiration. The peasants, who gather the plants on the Alps and Pyrenees, are said to use it with success against the biting of mad dogs, and to cure the colic. It is remarkable, that the monks-hoods with blue flowers are much more virulent than

the yellow or white-flowered kinds. Miller asserts that the huntsmen of the wolves and other wild beasts on the Alps, dip their arrows into the juice of those plants, which renders the wounds made by them deadly.

MONMOUTH (James, duke of), son to Charles II. by Mrs Lucy Walters, was born at Rotterdam in 1649. Upon the Restoration, he was called over to England, where the king received him with all imaginable joy, created him earl of Orkney (which was changed into that of Monmouth), and he took his seat in the house of peers in the ensuing session of parliament. He married Anne, the heiress of Francis earl of Buccleugh; and hence it came to pass that he had also the title of *Buccleugh*, and took the surname of *Scot*, according to the custom of Scotland. In 1668 his father made him captain of his life-guard of horse; and in 1672 he attended the French king in the Netherlands, and gave proofs of bravery and conduct. In 1673 the king of France made him lieutenant-general of his army, with which he came before Maëtricht, and behaved himself with incredible gallantry, being the first who entered it himself. He returned to England, was received with all possible respect, and was elected chancellor of the university of Cambridge. After this he went to assist the prince of Orange to raise the siege of Mons, and did not a little contribute towards it. He returned to England; and was sent, in quality of his father's general, to quell an insurrection in Scotland, which he effected: but soon after he fell into disgrace; for, being a Protestant, he was deluded into ambitious schemes, upon the hopes of the exclusion of the duke of York: he conspired against his father and the duke; and when the latter came to the throne by the title of *James II.* he openly appeared in arms, encouraged by the Protestant army; but coming to a decisive battle before he had sufficient forces to oppose the royal army, he was defeated, taken soon after concealed in a ditch, tried for high-treason, condemned, and beheaded in 1685, aged 36. See BRITAIN, n° 242. 249—265.

MONMOUTH, the capital of the county of Monmouthshire in England. It has its name from its situation at the conflux of the Monow, or Mynwy, and Wye. Here was a castle in William the Conqueror's time, which Henry III. took from John baron of Monmouth. It afterwards came to the house of Lancaster, who bestowed many privileges upon the town. Here Henry V. surnamed *of Monmouth*, was born. The famous historian Geoffrey was also born at this place. Formerly it gave the title of *earl* to the family of Carey, and of *duke* to king Charles the second's eldest natural son; but now of *earl* to the Mordaunts, who are also earls of Peterborough. It is a populous and well-built place, and carries on a considerable trade with Bristol by means of the Wye. W. Long. 2. 30. N. Lat. 51. 47.

MONMOUTHSHIRE, a county of England; anciently reckoned a part of Wales, but in Charles the second's time taken into the Oxford circuit, and made an English county. It has Brecknockshire and Herefordshire on the north, from the latter of which it is separated by the Monow; Gloucestershire on the east, from which it is separated by the Wye; Glamorganshire on the west, and the river Rumney running between them; and on the south it is bounded by the

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shire.



**Monochord** Severn sea, into which these rivers, and also the *Uffe*, discharge themselves. It is about 29 miles in length, and 20 in breadth. The country is in some parts woody, and in others hilly: yet the air is nowhere bad, nor the soil barren; for the hills feed large flocks of black cattle, sheep and goats, and the valleys produce plenty of corn. It is also well watered; and so plentifully supplied with coal, that the poorest cottager can afford to keep a good fire all the winter. The county sends three members to parliament. The principal manufacture is flannel.

**MONOCHORD**, a musical instrument with only one string, used to try the variety and proportion of sounds. It is formed of a rule, divided and subdivided into several parts, on which there is a moveable string stretched upon two bridges at each extreme. In the middle between these is a moveable bridge, by means of which, in applying to it the different divisions of the line, the sounds are found to bear the same proportion to each other as the division of the line cut by the bridge. There are also monochords with 48 fixed bridges. This instrument is also called the *harmonical canon*, or the *canonical rule*, because it serves to measure the degrees of gravity or acuteness.—*Monochord* is also used for any musical instrument that consists of only one string or chord; in this sense the trumpet marine may properly be called a *monochord*.

**MONODON**, in ichthyology, a genus of fishes belonging to the order of cete. It has a long wreathed tooth in the upper jaw, which perforates the upper lip, and has the appearance of a horn; from this circumstance it has got the name of the *unicorn-fish*. It is the *narwhal* of Pontopidan, and is of the whale kind. Sometimes it grows to 25 feet in length; but the usual size is from 16 to 20.

**MONODY**, in ancient poetry, a mournful kind of song, sung by a person all alone, to give vent to his grief. The word is derived from *μονος* "alone," and *οιδω* "I sing."

**MONOECIA**, from *μονος* "alone," and *οικια* "a house;" the name of the 21st class in Linnæus's sexual method. See **BOTANY**, n° 1296.

**MONOGRAM**, a character or cypher, composed of one, two, or more letters, interwoven; being a kind of abbreviation of a name, anciently used as a seal, badge, arms, &c.

**MONOGYNIA**, from *μονος* "alone," and *γυνω* "a woman;" the name of the first order or subdivision in the first 13 classes of Linnæus's sexual method; consisting of plants which, besides their agreement in their classic character, generally derived from the number of their stamina, have only one stile, or female organ.

**MONOMOTAPA**, a country of Africa, has the maritime kingdom of Sofala on the east, the river Del Spiritu Santo on the south, the mountains of Caffraria on the west, and the river Cauma on the north, which parts it from Monoemugi. The air of this country is very temperate; the land fertile in pastures and all the necessaries of life, being watered by several rivers. The inhabitants are rich in black cattle, which they value more than gold. They have a vast number of elephants, as appears from the great quantity of ivory that is exported from hence. There are many gold-mines, and the rivers that run through their veins carry a great deal of gold-dust along with

them. The inhabitants are lovers of war, which is the employment followed by all those who do not apply themselves to commerce. This country is divided into seven provinces or petty kingdoms, vassals to the king; viz. Monomotapa Proper, Quiteve, Manica, Inhambana, Inhemiur, Sabia, and Sofala.

**MONOPETALOUS**, in botany, a term applied to flowers that have only one petal or flower-leaf.

**MONOPOLY**, one or more persons making themselves the sole masters of the whole of a commodity, manufacture, and the like, in order to make private advantage of it, by selling it again at a very advanced price. Or it is a licence or privilege allowed by the king for the sole buying and selling, making, working, or using any thing whatsoever.—Monopolies had been carried to an enormous height during the reign of queen Elizabeth; and were heavily complained of by Sir Edward Coke, in the beginning of the reign of king James the first: but were in great measure remedied by statute 2: Jac. I. c. 3. which declares such monopolies to be contrary to law, and void; (except as to patents, not exceeding the grant of fourteen years, to the authors of new inventions; and except also patents concerning printing, saltpetre, gunpowder, great ordinance, and shot); and monopolists are punished with the forfeiture of treble damages and double costs, to those whom they attempt to disturb; and if they procure any action, brought against them for these damages, to be stayed by any extrajudicial order, other than of the court wherein it is brought, they incur the penalties of *praemunire*. Combinations also among victuallers or artificers, to raise the price of provisions, or any commodities, or the rate of labour, are in many cases severely punished by particular statute; and, in general, by statute 2 & 3 Edward VI. c. 15. with the forfeiture of 10*l.* or twenty days imprisonment, with an allowance of only bread and water, for the first offence; 20*l.* or the pillory, for the second; and 40*l.* for the third, or else the pillory, loss of one ear, and perpetual infamy. In the same manner, by a constitution of the emperor Zeno, all monopolies and combinations to keep up the price of merchandise, provisions, or workmanship, were prohibited, upon pain of forfeiture of goods and perpetual banishment.

**MONOSYLLABLE**, in grammar, a word that consists only of one syllable, and is composed either of one or more letters pronounced at the same time. The too frequent use of monosyllables has a very bad effect in English poetry, as Mr Pope both intimates and exemplifies in the same verse, viz.

"And ten slow words oft creep in one dull line."

**MONOTONY**, an uniformity of sound, or a fault in pronunciation, when a long series of words are delivered in one unvaried tone. See **READING**.

**MONOTROPA**, **BIRD'S-NEST**; a genus of the monogynia order, belonging to the decandria class of plants. There are two species; of which the only remarkable one is the hippopitylis, a native of Britain and some of the more northerly kingdoms of Europe. It is about five inches high, having no other leaves than oval scales, and terminated with a nodding spike of flowers, which in the seed-time becomes erect: the whole plant is of a pale-yellow colour, smelling like the primrose, or like beans in blossom. The country-people in Sweden give the dried plant to

Monro. cattle that have a cough.

MONRO (Dr Alexander, senior), a most eminent physician and anatomist, was defended by his father from the family of Monro of Milton, which had large possessions in the county of Ross; and by his mother, from that of Forbes of Culloden.

His father John, youngest son of Sir Alexander Monro of Bearcrofts, was bred to physic and surgery, and served for some years as a surgeon in the army under King William in Flanders: but, for several successive years, obtaining leave of absence from the army in the winter, he during that season resided with his wife in London, where his son Alexander was born in the 1697. About three years thereafter, he quitted the army, and went to settle as a surgeon at Edinburgh; where his knowledge in his profession, and engaging manners, soon introduced him into an extensive practice.

The son shewed an early inclination to the study of physic; and the father, after giving him the best education that Edinburgh then afforded, sent him successively to London, Paris, and Leyden, to improve himself further in his profession. At London, he attended the lectures of Messrs Hawkebee and Whiston on experimental philosophy, and the anatomical demonstrations of Mr Cheselden. At Paris, he attended the hospitals, and the lectures which were read on the different branches of physic and surgery at that time. Towards the end of autumn 1718, he went to Leyden, and studied under the great Boerhaave; by whom he was particularly esteemed.

On his return to Edinburgh in autumn 1719, Messrs Drummond and Macgill, who were then conjunct nominal professors and demonstrators of anatomy to the surgeons company, having resigned in his favour, his father prevailed on him to read some public lectures on anatomy, and to illustrate them by shewing the curious anatomical preparations which he had made and sent home when abroad. He at the same time persuaded Dr Alison, then a young man, to give some public lectures on botany. Accordingly, in the beginning of the winter 1720, these two young professors began to give regular courses of lectures, the one on the materia medica and botany, the other on anatomy and surgery; which were the first regular courses of lectures on any of the branches of medicine that had ever been read at Edinburgh, and may be looked upon as the opening of that medical school which has since acquired such great reputation all over Europe.

In summer 1721 and 1722, Dr Monro, by the persuasion of his father, read some lectures on surgical subjects; particularly on wounds and tumours, which he never would publish, having wrote them in a hurry and before he had much experience; but inserted from time to time the improvements he thought might be made in surgery, in the volumes of Medical Essays and Observations to be hereafter mentioned.

About the year 1720, his father communicated to the physicians and surgeons at Edinburgh, a plan, which he had long formed in his own mind, of having the different branches of physic and surgery regularly taught at Edinburgh; which was highly approved of by them, and by their interest regular professorships of anatomy and medicine were instituted in the university. His son, Dr Monro, was first made univer-

sity-professor of anatomy; and two or three years afterwards, Drs Sinclair, Rutherford, Innes, and Plummer, were made professors of medicine; the professorship of materia medica and botany, which Dr Alison then held, having been added to the university many years before. Immediately after these gentlemen were elected professors, they began to deliver regular courses of lectures on the different branches of medicine, and they and their successors have uniformly continued so to do every year.

The plan for a medical education at Edinburgh was still incomplete without an hospital, where students could see the practice of physic and surgery, as well as hear the lectures of the professors. A scheme was therefore proposed by Dr Monro's father, and others, particularly the members of the royal college of physicians and board of surgeons, for raising by subscription a fund for building and supporting an hospital for the reception of diseased poor; and our author published a pamphlet setting forth the advantages that would attend such an institution. In a short time a considerable sum of money was raised, a small house was fitted up, and patients were admitted into it, and regularly attended by many of the physicians and surgeons in town. The fund for this charity increasing very considerably, in a great measure from the activity and influence of that very worthy citizen and magistrate George Drummond, Esq. the foundation was laid of the present large, commodious, and useful hospital, the *Royal Infirmary*; in the planning of which Dr Monro suggested many useful hints, and in particular the elegant room for chyrurgical operations was designed and executed under his direction. Provost Drummond and he were nominated the building committee; and the fabric was entirely completed in a short space of time. It has since been so largely endowed, as to be capable of receiving a great number of diseased poor, whose cases the students of physic and surgery have an opportunity of seeing daily treated with the greatest attention and care by physicians and surgeons eminent in their profession; and a register of the particulars of all the cases which have been received into the house since its first opening has been kept, in books appropriated for that purpose, for the use of the students.

In order to make the hospital of still further use to the students, Dr Monro frequently, while he continued professor of anatomy, gave lectures on the chyrurgical cases; and the late judicious physician, Dr Rutherford professor of the practice of physic, began, in the year 1748, to deliver clinical lectures, to be continued every winter, on the most remarkable cases in the hospital.

Doctor Monro, though he was elected professor of anatomy in the year 1721, was not received into the university till the year 1725, when he was inducted along with that great mathematician the late Mr Colin Maclaurin, with whom he ever lived in the strictest friendship. From this time he regularly every winter gave a course of lectures on anatomy and surgery, from October to May, upon a most judicious and comprehensive plan: A talk in which he persevered with the greatest assiduity, and without the least interruption, for near forty years; and so great was the reputation he had acquired, that students flocked to him from the most distant corners of his majesty's dominions.

Monro.

In 1759, our professor entirely relinquished the business of the anatomical theatre to his son Dr Alexander, who had returned from abroad, and had assisted him in the course of lectures the preceding year. But after this resignation, he still endeavoured to render his labours useful to mankind, by reading clinical lectures at the hospital for the improvement of the students; of which Dr Duncan, who was one of his pupils, has given the following account. "There I had myself the happiness of being a pupil, who profited by the judicious conduct of his practice, and was improved by the wisdom and acuteness of his remarks. I have indeed to regret that I attended only the last course of his lectures in which he had ever a share, and at a time when he was subjected to a disease which proved at length fatal. Still, however, from what I saw and from what I heard, I can venture to assert, that it is hardly possible to conceive a physician more attentive to practice, or a preceptor more anxious to communicate instructions. His humanity, in the former of these characters, led him to bestow the most anxious care on his patients while they were alive; and his zeal in the latter induced him to make them the subject of useful lessons when they happened to die.—In the different stations of physician, of lecturer, and of manager in the hospital, he took every measure for inquiring into the causes of diseases by dissection. He personally attended the opening of every body; and he not only dictated to the students an accurate report of the dissection, but with nice discrimination contrasted the diseased and sound state of every organ. Thus, in his own person, he afforded to the students a conspicuous example of the advantages of early anatomical pursuits, as the happiest foundation for a medical superstructure. His being at once engaged in two departments, the anatomical theatre and clinical chair, furnished him with opportunities both on the dead and living body, and placed him in the most favourable situation for the improvement of medicine; and from these opportunities he derived every possible advantage which they could afford."

His father, old Mr Monro, lived to an advanced age; and enjoyed the unspeakable pleasure of beholding a son, esteemed and regarded by mankind, the principal actor in the execution of his favourite plan, the great object of his life, the founding a seminary of medical education in his native country: The son, who survived him near 30 years, had the satisfaction to behold this seminary of medical education frequented yearly by 300 or 400 students, many of whom came from the most distant corners of his majesty's dominions, and to see it arrive to a degree of reputation far beyond his most sanguine hopes, being equalled by few, and inferior to none, in Europe.

Few men were members of more societies than Dr Monro; still fewer equally assiduous in their attendance of those which in any way tended to promote public utility. He was a manager of many public charities; and not only a member of different medical societies, but likewise of several others instituted for promoting literature, arts, sciences, and manufactures in Scotland, and was one of their most useful members. While he was held in high estimation at home, he was equally esteemed and respected abroad, and was elected member of the royal society of London, and an honorary member of the royal academy of surgery at Paris.

Monro.

He was not only very active in the line of his own profession, but as a citizen and general member of the community; for, after he had resigned the anatomical chair to his son, he executed with the strictest punctuality the duties of several engagements both of a civil and political nature: He was a director of the Bank of Scotland, a Justice of the Peace, a Commissioner of High-roads, &c.

At length, after a life spent in the most active industry, he became afflicted with a tedious and painful disease, which he bore with equal courage and resignation till his death, which happened on July 10th 1767, in the 70th year of his age.

Dr Monro was a man of great humanity and sweetness of temper, and endowed with a singular liberality of sentiment. He was a sincere friend, and an agreeable companion; an affectionate husband, and a kind father; and was never more happy than when he could serve those whom he thought deserving.

Of his works, the first in order is his *Osteology*, which was written for the use of students, but is capable also of affording instruction to the oldest and most experienced practitioner; as, besides a minute description of the parts copied from nature, it every where abounds with new and important observations immediately applicable to practice. It has been translated into many different languages; has passed through numerous editions; and has been reprinted in foreign countries in the most superb manner, accompanied with elegant and masterly engravings. His description of the *Lacteal Sac* and *Thoracic Duct* contains the most accurate account of that important part of the body which has been yet published; and his *Anatomy of the Nerves* will transmit to posterity an excellent example of accurate dissection, faithful description, and ingenious reasoning. The six volumes of *Medical Essays and Observations*, published by a society in Edinburgh, are universally known and esteemed. To that society he was appointed secretary; but, after the publication of the first volume, to which he had largely contributed, the members growing remiss in their attendance, he became the sole collector and publisher of the work: To him we are therefore in a great measure indebted for those numerous and important discoveries with which this publication has enriched every department of medical knowledge. In the two first volumes of the *Physical and Literary Essays*, published by the physical society of Edinburgh, in which he had the rank of one of the presidents, we find several papers written by him, which are not the least ornaments of that collection. His account of the *Success of Inoculation in Scotland* may be considered as his last publication: It demonstrates his extensive correspondence and indefatigable industry, and has had great influence in promoting that salutary practice. Besides these, he was also the author of several other elegant and masterly productions, which were either never published, or were published without his knowledge and from incorrect copies. A collection of all his works, properly arranged, corrected, and illustrated with copperplates, has been published by Dr Alexander Monro, his son and successor in the anatomical chair, in a splendid quarto volume, printed for Elliot, Edinburgh, 1781; to which is prefixed a life of the author, by another of his sons, Dr Donald, physician in London. The observation of an excellent judge,

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judge, the illustrious Haller, concerning our author's Medical Essays and Observations, which now form a part of this collection, may with no less justice be applied to the whole: It is a "book which ought to be in the possession of every medical practitioner."

MONS, an ancient, large, handsome, rich, and very strong city of the Austrian Netherlands, in Hainault. There is a chapter, consisting of 30 ladies of distinction, who have the liberty of leaving the community when they intend to marry. They have several manufactures, and a good trade. It was taken by the allies in 1709, and by the French in July 1746; but rendered back by the treaty of Aix-la-Chapelle, after the fortifications were demolished. It stands partly on a hill and partly on a plain, in a marshy soil, on the rivers Haine and Trouille, by which the country about it may be overflowed when they please. E. Lon. 3. 39. N. Lat. 50. 25.

Mons Sacer, (anc. geog.), a mountain of the Sabines beyond the Anio, to the east of Rome; whither the common people retired once and again to avoid the tyranny of the patricians. From this secession, and the altar of *Jupiter Terribilis* erected there, the mountain took its name.

MONSEIGNEUR, "MY LORD;" a title of honour which the French in writing or speaking to dukes, peers, archbishops, bishops, and presidents a mortier. *Monsieur*, absolutely used, is a title now restrained to the dauphin of France; thus it is said an officer belonging to *Monsieur*: but this custom was not introduced till the reign of Lewis XIV. the dauphin before that time being called *Monsieur le Dauphin*.

MONSIEUR, a title of civility used by the French, in speaking to or of their equals, or those that are but little below them. Thus a duke or a marquis, speaking to an equal or inferior, uses the word *Monsieur*; and a mechanic speaking to a mechanic, gives him the same title: but nobody calls the French king *Monsieur*, except the children of France. The word is compounded of *mon*, "my," and *seigneur*, "sir."

In France, the inscriptions of all letters run thus: *A monsieur monsieur* such-a-one. *Monsieur* absolutely used, is a title given to the second son of France, and to the king's brother.

MONSOON, in physiology, a species of trade-wind in the East Indies, which, for six months, blows constantly the same way, and the contrary way the other six months. See WIND.

MONSON (Sir William), a brave English admiral, third son of Sir John Monson of South Carlton in Lincolnshire, was born in 1569. He was employed in many expeditions against the Spaniards in Queen Elizabeth's time, and was highly honoured; the queen knighted him for his services in the earl of Essex's expedition to Cadiz, where he assisted much by his wise and moderate counsel to the earl. Military men were no favourites with James I. therefore, on the death of the queen, he received no recompence or pay beyond the ordinary service in which he was engaged: nevertheless, as admiral of the narrow seas, he supported the honour of the British flag against the infant insolence of the Dutch states, of which he frequently complains in his Navy Tracts; and protected our trade against the encroachments of France. He had the misfortune to fall into disgrace by his vigilance, and was imprisoned in the Tower through the resentment of

some powerful courtiers; yet he was discharged, and wrote a vindication of his own conduct, intitled, "Concerning the insolencies of the Dutch, and a justification of Sir William Monson." He spent his latter days in peace and privacy, which he employed in digesting his Navy Tracts; and died in 1643. Part of these tracts were printed in 1682; and they were afterwards all included in Churchill's Collection of Voyages.

MONSTER; a birth or production of a living thing degenerating from the proper and usual disposition of parts in the species it belongs to. As, when there are too many members, or too few; or some of them are extravagantly out of proportion, either on the side of defect or excess. The word comes from the Latin *monstrum*, of *monstrando*, "shewing." Whence also the box wherein relics were anciently kept to be shewn, was called *monstrum*. Dugdale mentions an inventory of the church of York with this article, *Item unum monstrum cum ossibus sancti Petri in Beryl, & crucifixo in summitate*.

Aristotle defines a monster to be a defect of nature, when acting towards some end, it cannot attain to it, by reason some of its principles are corrupted.

Monsters do not propagate their kind; for which reason some rank males among the number of monsters; as also hermaphrodites.

Females which bring forth twins, are found most liable to produce monsters. The reason, probably, is owing to this; that though the twins are covered with one common chorion, yet they have each their separate amnios, which, by their contiguity may chance to grow together, and so occasion a confusion or blending of the parts. Hence so many double creatures.

F. Malebranche accounts for the production of monsters in the animal-world, thus: The creator has established such a communication between the several parts of his creation, that we are not only naturally led to imitate one another, i. e. have a disposition to do the same things and assume the same manners with those with whom we converse; but also have certain natural dispositions which incline us to compassion as well as imitation. These things most men feel, and are sensible of; and therefore need not be proved. The animal-spirits, then, are not only naturally carried into the respective parts of the body to perform the same actions and the same motions which we see others do, but also to receive in some manner their wounds, and take part in their sufferings.

Experience tells us, that when we look attentively on any person severely beaten, or that hath a large wound, ulcer, or the like, the spirits immediately flow into those parts of our body which answer to those we see suffer in the other; unless their course be stopped from some other principle. This flux of spirits is very sensible in persons of a delicate constitution, who frequently shudder, and find a kind of trembling in the body on these occasions; and this sympathy in bodies produces compassion in the mind.

Now, it must be observed, that the view of a wound, &c. wounds the person who views it the more strongly and sensibly, as the person is more weak and delicate; the spirits making a stronger impression on the fibres of a delicate body, than in those of a robust one. Thus strong, vigorous men, &c. see an execution without much concern, while women, &c. are struck with pity and horror. As to children kill in their mother's womb,

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womb, the fibres of their flesh being incomparably finer than those in women, the course of the animal-spirits must necessarily produce much greater alterations.

These things being laid down, monsters are easily accounted for. Suppose, *v. gr.* a child born a fool, and with all its legs and arms broke in the same manner as those of criminals in some countries are; which case we choose to instance in, because we are told from Paris that such a monster was actually born there, and lived in one of their hospitals 20 years: the cause of this accident, according to the principles laid down, was, that the mother seeing a criminal executed, every fibre given to the poor man, struck forcibly the imagination of the woman; and, by a kind of counter-frore, the tender and delicate brain of the child. Now, though the fibres of the woman's brain were strangely shaken by the violent flux of animal-spirits on this occasion, yet they had strength and consistence enough to prevent an entire disorder; whereas the fibres of the child's brain being unable to bear the shock of those spirits, were quite ruined, and the ravage was great enough to deprive him of reason all his lifetime.

Again; the view of the execution frightening the woman, the violent course of the animal-spirits was directed forcibly from the brain to all those parts of the body corresponding to the suffering parts of the criminal; and the same thing must happen in the child. But in regard the bones of the mother were strong enough to resist the impulse of those spirits, they were not damaged: And yet the rapid course of these spirits could easily overpower and break the tender and delicate fibres of the bones of the child; the bones being the last parts of the body that are formed, and having a very slender consistence while the child is yet in the womb.

To which it may be here added, that had the mother determined the course of these spirits towards some other part of her body by tickling or scratching herself vehemently, the child would not in all probability have had its bones broken; but the part answering that to which the motion of the spirits was determined, would have been the sufferer. Hence appears the reason, why women in the time of gestation, seeing persons, &c. marked in such a manner in the face, impress the same mark on the same parts of the child: and why, upon rubbing some hidden part of the body when startled at the sight of any thing or agitated with any extraordinary passion, the mark or impression is fixed on that hidden part rather than on the face of the child. From the principles here laid down, may most, if not all, the phenomena of monsters be easily accounted for.

MONTAGUE (Edward), earl of Sandwich, an illustrious Englishman, who shone from the age of 19, and united the qualifications of general, admiral, and statesman; yet there were strange inconsistencies in his character. He acted early against Charles I.; he persuaded Cromwell, whom it is said he admired, to take the crown; and he was zealous for the restoration of Charles II. All this is imputed to a fond and unaccountable passion which he had for royalty. Upon general Monk's coming into England, he sailed with the fleet to Holland, and soon after he had the honour to convey his majesty to England. For this he was created knight of the garter; and on the 12th of July 1660 he was created baron Montague

of St Neots in the county of Huntingdon, Viscount Hinchinbrooke in the same county, and earl of Sandwich in Kent, sworn one of his majesty's most honourable privy-council, made master of the king's wardrobe, admiral of the Narrow Seas, and lieutenant-admiral to the duke of York, as lord high admiral of England.

When the Dutch war broke out in 1664, and the duke of York took upon himself the command of a fleet as high-admiral, his lordship commanded the blue squadron, and by his industry and care abundance of the enemies ships were taken; and in the great battle fought on the third of June 1665, in which the Dutch lost admiral Opdam, and had 18 men of war taken and 14 destroyed, a large share of the honour of the victory was justly given to the conduct of the earl of Sandwich. On the return of the English navy, the command of the whole fleet was given to the earl of Sandwich, which he was ordered to put as speedily as possible in a condition to return to the coast of Holland. Accordingly the earl sailed on the fifth of July with 60 men of war to the Dutch coast; when finding that their East India and Smyrna fleets were to return home north about, he steered for the coast of Norway, and found they had taken shelter in the port of Bergen, where the fleet were attacked: but leaving them there, and sailing back towards the coast of Holland, he met with four Dutch East Indiamen, with several other merchant-ships, under a good convoy, and took eight men of war, two of their East India ships, and 20 sail of merchant-men; and a few days after, a part of the fleet falling in with 18 of the Hollanders, the greatest part of them were also taken, with four Dutch men of war, and above 1000 prisoners. On his return he was received by the king with distinguished marks of favour; and soon after, he was sent ambassador-extraordinary to the court of Madrid, to mediate a peace between the crowns of Spain and Portugal; when he had the happiness to conclude a peace between the two nations to their mutual satisfaction.

On the breaking out of the last Dutch war, his lordship went to sea with the duke of York, and commanded the blue squadron; the French admiral, count d'Estrees, commanding the white. The fleet was at sea in the beginning of the month of May, and coming to an anchor in Southwold-bay in order to take in water, we are told, that on the 27th many officers and seamen were permitted to go on shore, and were at Southwold, Dunwich, and Aldborough; when, the weather being hazy, the earl gave it as his opinion, that, the wind standing as it did, the fleet rode in danger of being surpris'd by the Dutch; and indeed, between two and three the next morning, they were informed of their approach, upon which his royal highness made the signal for weighing anchor. The blue squadron was out first, the red next, and the white was much a-stern. The earl of Sandwich in the Royal James, which carried 100 guns, began the fight, and fell furiously on the Squadron of Van Ghent in order to give the rest of his fleet time to form; when captain Brskel, in the Great Holland, attacked the Royal James; but was soon disabled, as were several other men of war, and three fire-ships sunk. By this time most of his men were killed; and the hull of the Royal James was so pierced with shot, that it was impossible to carry her off. In this distress he might have been relieved

by

Montague. by his vice-admiral Sir Joseph Jordan, had not that gentleman been more solicitous about afflicting the duke. When therefore he saw him fail by, heedless of the condition in which he lay, he said to those who were about him, "There is nothing left for us now, but to defend the ship to the last man." Being at length grappled by a fourth fire-ship, he begged his captain Sir Richard Haddock, and all his servants, to get into the boat and save themselves, which they did: yet some of the sailors refused to quit the admiral, and staying endeavoured to extinguish the fire, but in vain; the ship blew up about noon. His lordship's body was found about a fortnight after, and was interred with great state in Henry VII.'s chapel.

We have of his lordship's writing, 1. *The Art of Metals*, in which is declared the manner of his generation, translated from the Spanish of Alvaro Alonzo Barba, 8vo. 2. Several letters during his embassy to Spain, published with Arlington's letters. 3. A letter to secretary Thurloe. 4. Original letters and negotiations of Sir Richard Fanshawe, the earl of Sandwich, the earl of Sunderland, and Sir William Godolphin, wherein divers matters between the three crowns of England, Spain, and Portugal, from the year 1663 to 1678, are set in a clear light, 2 vols 8vo.

MONTAGUE (Lady Mary Wortley,) eminent by her *Letters*, was daughter of the first duke of Kingston, and died in 1762.

MONTAGUE (Edward Wortley,) son of the former, passed through such variegated scenes, that a bare recital of them would favour of the marvellous. From Westminster school, where he was placed for education, he ran away three several times. He exchanged clothes with a chimney-sweeper, and he followed for some time that sooty occupation. He next joined himself to a fisherman, and cried flounders in Rotherhithe. He then sailed as a cabin-boy to Spain; where he had no sooner arrived, than he ran away from the vessel, and hired himself to a driver of mules. After thus vagabondizing it for some time, he was discovered by the consul, who returned him to his friends in England. They received him with a joy equal to that of the father of the prodigal son in the gospel. A private tutor was employed to recover those rudiments of learning which a life of dissipation, of blackguardism, and of vulgarity, might have obliterated. Wortley was sent to the West-Indies, where he remained some time; then returned to England, acted according to the dignity of his birth, was chosen a member, and served in two successive parliaments. His expences exceeding his income, he became involved in debt, quitted his native country, and commenced that wandering traveller he continued to the time of his death. Having visited most of the eastern countries, he contracted a partiality for their manners. He drank little wine; a great deal of coffee; wore a long beard; smoked much; and, even whilst at Venice, he was habited in the eastern style. He sat cross-legged in the Turkish fashion through choice. With the Hebrew, the Arabic, the Chaldaic, and the Persian languages, he was as well acquainted as with his native tongue. He published several pieces. One on the "Rise and Fall of the Roman Empire." Another an exploration of "The Causes of Earthquakes."—As this gentleman was remarkable for the uncommon incidents which attended his life, the close of that life was no less

marked with singularity. He had been early married to a woman, who aspired to no higher a character than that of an industrious washerwoman. As the marriage was solemnized in a frolic, Wortley never deemed her sufficiently the wife of his bosom to cohabit with her. She was allowed a maintenance. She lived contented, and was too submissive to be troublesome on account of the conjugal rites. Mr Montague, on the other hand, was a perfect patriarch in his manners. He had wives of almost every nation. When he was with Ali Bey in Egypt, he had his household of Egyptian females, each striving who should be the happy she who could gain the greatest ascendancy over this Anglo-Eastern bawlaw. At Constantinople, the Grecian women had charms to captivate this unsettled wanderer. In Spain a Spanish brunette, in Italy the olive-complexioned female, were solicited to partake the honours of the bridal-bed. It may be asked what became of this group of wives? Mr Montague was continually shifting the place, and consequently varying the scene. Did he travel with his wives, as the patriarchs did with their flocks and herds? No such thing. Wortley, considering his wives as bad travelling companions, generally left them behind him. It happened, however, that news reached his ears of the death of the original Mrs Montague the washerwoman. Wortley had no issue by her; and without issue male, a very large estate would revert to the second son of lord Bute. Wortley, owing the family no obligations, was determined, if possible, to defeat their expectations. He resolved to return to England and marry. He acquainted a friend with his intentions, and he commissioned that friend to advertise for any young decent woman who might be in a pregnant state. Several ladies answered it. One out of the number was selected, as being the most eligible object. She waited with eagerness for the arrival of her expected bridegroom; but, behold, whilst he was on his journey, death very impetuously arrested him in his career.

MONTAGUE (Charles,) earl of Halifax, fourth son of George Montague of Harton in Northamptonshire, Esq; son of Henry the first earl of Manchester, was born in 1661. He was educated at Westminster-school and Cambridge, shewed very early a most pregnant genius, and quickly made great progress in learning. In 1684, he wrote a poem on the death of king Charles II. in which he displayed his genius to such advantage, that he was invited to London by the earl of Dorset; and upon his coming thither he soon increased his fame, particularly by a piece which he wrote in conjunction with Prior, published at London in 1687, under the title of *The Hind and the Panther transferred to the Story of the Country-mouse and the City-mouse*. Upon the abdication of king James II. he was chosen one of the members of the convention, and recommended by the earl of Dorset to king William, who immediately allowed him a pension of 500*l. per annum*. Having given proofs of his great abilities in the house of commons, he was made one of the commissioners of the treasury, and soon after chancellor of the exchequer; in which post he brought about that great work of reconciling all the current money of the nation. In 1698, he was appointed first commissioner of the treasury; and in 1679, was created a peer of England, by the title of *Baron Halifax* in the county of

Montaigne, of York. In 1701, the house of commons impeached him of six articles, which were dismissed by the house of Lords. He was attacked again by the house of commons in 1702, but without success. In 1705, he wrote, An answer to Mr Bromley's speech in relation to the occasional Conformity-bill. In 1706, he was one of the commissioners for the union with Scotland; and upon passing the bill for the naturalization of the illustrious house of Hanover, and for the better security of the succession of the crown in the Protestant line, he was made choice of to carry that act to Hanover. Upon the death of Queen Anne, when the king had taken possession of his throne, his lordship was appointed first commissioner of the treasury, and created earl of Halifax and knight of the garter. He died in 1715. His lordship wrote several other pieces besides those abovementioned; all which, with some of his Speeches, were published together in 1716, in an octavo volume.

MONTAIGNE (Michael de), a French gentleman, was born in Perigord in 1533. His father educated him with great care, and made him learn Latin as other children learn their mother-tongue. His tutors were Nicholas Gronchi, who wrote *De Comitibus Romanorum*; William Guarenti, who wrote on Aristotle; George Buchanan; and M. Anthony Muret. He was also taught Greek by way of recreation; and because some think that starting children out of their sleep spoils their understanding, he was awakened every morning with the sound of music. He was counsellor for a while in the parliament of Bourdeaux; afterwards made mayor of Bourdeaux. He published his *Essays*, so much known in the world, in 1580. Montaigne had a great deal of wit and subtlety, but no small share of conceit and vanity. The learned and ingenious are much divided in their opinion about his works. He died in 1592.

MONTANISTS, Christian heretics, who sprung up about the year 171, in the reign of the emperor Marcus Aurelius. They were so called from their leader, the heresiarch Montanus, a Phrygian by birth; whence they are sometimes styled *Phrygians* and *Cataphrygians*.

Montanus, it is said, embraced Christianity in hopes of rising to the dignities of the church. He pretended to inspiration; and gave out, that the Holy Ghost had instructed him in several points, which had not been revealed to the apostles. Priscilla and Maximilla, two enthusiastic women of Phrygia, presently became his disciples; and in a short time he had a great number of followers. The bishops of Asia, being assembled together, condemned his prophecies, and excommunicated those who dispersed them. Afterwards they wrote an account of what had passed to the western churches, where the pretended prophecies of Montanus and his followers were likewise condemned.

The Montanists, finding themselves exposed to the censure of the whole church, formed a schism, and set up a distinct society under the direction of those who called themselves *prophets*. Montanus, in conjunction with Priscilla and Maximilla, was at the head of the sect.

These sectaries made no alteration in the creed. They only held, that the Holy Spirit made Montanus his organ for delivering a more perfect form of discipline than what was delivered by the apostles. They

refused communion for ever to those who were guilty of Montanus's notorious crimes, and believed that the bishops had no authority to reconcile them. They held it unlawful to fly in time of persecution. They condemned second marriages, allowed the dissolution of marriage, and observed three lent.

The Montanists became separated into two branches; one of which were the disciples of Proclus, and the other of Æschines. The latter are charged with following the heterodoxy of Praxeas and Sabellius concerning the Trinity.

MONTANUS (Benedict Arias), a most learned Spanish theologian, born in the diocese of Badajoz, about the year 1528. He assisted at the council of Trent with great reputation; and his merit and writings recommended him to Philip II. of Spain, who employed him in publishing a new polyglot bible after the Complutensian edition, which was printed by the care of cardinal Ximenes. This bible was printed at Antwerp, whither Montanus went in 1571; and on his return to Spain he refused the bishopric which Philip offered him for his reward, but spent the rest of his days at Sevilla, where he died about the year 1598. Montanus had not only vast erudition, but great good sense; he loved solitude, was very laborious, never drank wine, and seldom ate flesh.

MONTECUCULI (Raymond de), generalissimo of the emperor's army, and one of the greatest commanders of his time, was born in the duchy of Modena, of a distinguished family in 1608. Ernest Montecuculi his uncle, who was general of the artillery in the Imperial army, resolved that he should serve first as a common soldier, and that he should pass through all the military degrees, before he was raised to command. This the young Montecuculi did with applause. In 1644, when he was at the head of 2000 horse, he surprised by a precipitate march 10,000 Swedes, who laid siege to Nemessau in Silesia, and obliged them to abandon their artillery and baggage; but a short time after, he was defeated and taken prisoner by the general Banier. Having obtained his liberty at the end of two years, he joined his troops to those of John de Wert; and defeated general Wrangel in Bohemia, who was killed in the battle. In 1657, the emperor made him general marshal de camp; and sent him to the assistance of John Casimir, king of Poland. Montecuculi vanquished Ragotzi prince of Transilvania, drove out the Swedes, and distinguished himself in an extraordinary manner against the Turks in Transilvania and Hungary. In 1673, he commanded the Imperial army against the French, and took Bonne; he then proceeded with feint marches in order to deceive Turenne, in which he obtained great honour. However, the command of that army was taken from him the next year; but it was restored to him in 1675, in order that he might make head against the great Turenne. All Europe had their eyes fixed on these two able warriors, who then made use of all the stratagems which genius and military knowledge were capable of suggesting. The marshal de Turenne was obtaining the superiority, when he was taken off by a cannon-ball. Montecuculi wept at the death of so formidable an enemy, and bestowed upon him the greatest praises. The great prince of Conde was the only French general that could deprive Montecuculi of the superiority he had obtained by Turenne's death. That prince

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was therefore sent to the Rhine, and stopped the Imperial general; who considered this last campaign as the most glorious of his life, not for his being conqueror, but for his not being conquered, when he was opposed by a Turenne and a Conde. He spent the rest of his life at the Imperial court; and died at Lintz, in 1680. He wrote *Memoirs*; the best edition of which is that of Strasbourg, in 1735.

MONTESQUIEU (Charles de Secondat) baron, a most illustrious Frenchman descended from an ancient and noble family of Guienne, was born at the castle of La Brede, near Bourdeaux, in 1689. The greatest care was taken of his education; and at the age of 20 he had actually prepared materials for his *Spirit of Laws*, by well-digested extracts from those immense volumes of civil law which he had studied, not barely as a civilian, but as a philosopher. He became a counsellor of the parliament of Bourdeaux in 1714, and was received president à mortier two years after. In 1721 he published his *Persian Letters*; in which, under the screen of Oriental manners, he satirized those of France, and treated of several important subjects by delicate transient glances: he did not avow this publication; but was no sooner pointed out as the author, than zeal without knowledge, and envy under the mask of it, united at once against the Persian Letters. He was received into the French academy in 1728; and having previously quitted his civil employments, he entirely devoted himself to his genius, and was no longer a magistrate but a man of letters. Having thus set himself at liberty, he travelled through Germany, Italy, Switzerland, Holland, and England, in which last country he resided three years, and contracted intimacies with the greatest men then alive; for Locke and Newton were dead. The result of his observations was, "that Germany was fit to travel in, Italy to sojourn in, England to think in, and France to live in." On his return he retired for two years to his estate at La Brede, where he finished his work *On the Causes of the Grandeur and Declension of the Romans*; which appeared in 1734. The reputation acquired by this last work only cleared the way for his greater undertaking, the *Spirit of Laws*, which was printed at Geneva in 2 vols 4to. 1750. This was immediately attacked by the adversaries of his Persian Letters, in a multitude of anonymous pamphlets; containing all the reproaches to which a liberal mind is exposed from craft and ignorance. M. Montesquieu drew up a defence of this work; which, for truth, moderation, and delicacy of ridicule, may be regarded as a model in its way. This great man was peaceably enjoying thatfulness of esteem which his great merits had procured him, when he fell sick at Paris, and died on the 10th of February 1755.—The following character of this great man is drawn by Lord Chesterfield. "His virtues did honour to human nature, his writings justice. A friend to mankind, he asserted their undoubted and unalienable rights with freedom, even in his own country; whose prejudices in matters of religion and government he had long lamented, and endeavoured, not without some success, to remove. He well knew, and justly admired, the happy constitution of this country, where fixed and known laws equally restrain monarchy from tyranny, and liberty from licentiousness. His works will illustrate his name, and survice him, as long as right reason, moral obligation,

and the true spirit of laws, shall be understood, respected, and maintained."—As to his personal qualities, we are told by his eulogist M. d'Alembert, that "he was of a sweet, gay, and even temper. His conversation was spirited, agreeable, and instructive. Nobody told a story in a more lively manner, or with more grace and less affectation. He had frequent absence of mind; but always awakened from it by some unexpected stroke that re-animated the languishing conversation. Tho' he lived with the great, he retired whenever he could to his estate in the country, and there met his books, his philosophy, and his repose. Surrounded at his leisure-hours with peasants, after having studied man in the commerce of the world, he studied him in those simple people solely instructed by nature. With them he cheerfully conversed; he endeavoured, like Socrates, to find out their genius, and appeared as happy with them as in the most brilliant assemblies; especially when he reconciled their differences, and by his beneficence relieved them from their distresses."

Besides the works already mentioned, M. Montesquieu wrote several small pieces, as the Temple of Gnidus, Lyfimachus, and Essay upon Taste, which is left unfinished. His works have been collected since his death, and printed at Paris in a splendid edition, in quarto. They have likewise all of them been translated into English.

MONTFAUCON (Bernard de), a very learned Benedictine of the congregation of St Maur, singularly famous for his knowledge in Pagan and ecclesiastical antiquities, was born of an ancient and noble family in Languedoc, in 1655. He served for some time in the army; but the death of his parents mortified him so with regard to the world, that he commenced Benedictine monk in 1675, and applied himself intently to study. Though Montfaucou's life was long, healthy, retired, and laborious, his voluminous publications seem sufficiently to have employed the whole; exclusive of his greatest undertaking, for which he will be always memorable. This was his *Antiquité expliquée*, written in Latin and French, illustrated with elegant plates, in 10 vols folio, to which he added a supplement of 5 vols more. He died at the abbey of St Germain in 1741.

MONTFERRAT, a province of Italy, with the title of a duchy; bounded on the east by the duchy of Milan, and part of the territory of Genoa; on the north, by the Vercelesse and Canavese; on the west, by Piedmont properly so called; and on the south by the territory of Genoa, from whence it is separated by the Appennine mountains. It contains 200 towns and castles; and is very fertile and well cultivated, abounding in corn, wine, oil, and silk. It belongs to the king of Sardinia. Casal is the capital town.

MONTGOMERY, the capital of a county of the same name in North Wales, took its name from Roger de Montgomery earl of Shrewsbury, who built the castle; but it is called by the Welsh *Tre Valdwain*, that is, Baldwin's town; having been built by Baldwin, lieutenant of the marches of Wales, in the reign of William I. The Welsh, after having put the garison to the sword, demolished it in 1095; but Henry III. rebuilt it, and granted it the privileges of a free borough, with other liberties. It is a large and tolerably well built town, in a healthful situation and fertile soil. It sends a member to parliament, and has

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Montgomeryshire  
Mont. the title of an earldom. It had also formerly a tower and castle; but they were demolished in the civil wars. W. Long. 3. 10. N. Lat. 52. 36.

MONTGOMERYSHIRE, a county of North Wales, 35 miles in length and 34 in breadth; bounded on the north by Merionethshire and Denbighshire, on the east by Shropshire, on the south by Radnor and Cardigan-shires, and on the west by another part of Merionethshire. It contains about 34,000 inhabitants, and between 5000 and 6000 houses. The county is full of high hills, with a few valleys and meadows fit for corn and pasture. The air is sharp and cold on the mountains, but is more mild in the valleys.

MONTH, the twelfth part of a year. See ASTRONOMY, n° 136.

MONTMORENCY, a town of France, with the title of a duchy, remarkable for the tombs of the dukes of this name. It is seated on a hill, near a large valley, fertile in fruits, especially excellent cherries. E. Long. 2. 24. N. Lat. 48. 59.

MONTMORENCY (Anne de), a peer, marshal, and countess, of France, and one of the greatest generals of the 16th century, defended, in 1512, the city of Mezieres against the emperor Charles V. and obliged the count of Nassau to raise the siege. The following year he was made marshal of France; and in 1525 following king Francis I. into Italy, he was taken with that prince at the battle of Pavia, which was fought contrary to his advice. The important services he afterwards rendered the state were rewarded by the sword of constable of France, with which he was presented by the king on the 10th of February 1538. He afterwards underwent various revolutions of fortune both at court and in the field. At last, being wounded at the battle of St Denis, which he gained on the 10th of November 1567, he died of his wounds two days after, at 74 years of age. It is said, that a cordelier attempting to prepare him for death, when he was covered with blood and wounds, after the battle of St Denis, he replied in a firm and steady voice: "Do you think that a man who has lived near 80 years with honour, has not learnt to die for a quarter of an hour?"

MONTPELIER, one of the handsomest towns of France, and the most considerable in Languedoc excepting Tholouse, is situated in E. Long. 4. 20. N. Lat. 45. 58. It hath a citadel, a bishop's see, a famous university where the art of medicine is taught, a royal academy of sciences, and a mint. The streets are very narrow and crooked; but always clean, because lying on a descent. The inhabitants are reckoned about 30,000 in number, among whom are a great number of physicians and apothecaries. This place is celebrated for its medicinal compositions, which are distributed all over Europe; particularly Hungary-water, oil of lavender, syrup of capillaire, essences, and perfumes. The air is extremely healthy, for which reason valetudinarians come hither from all parts for their recovery. It is seated on a hill, on the river Merdanson, which passes into several parts of the town through subterranean vaults.

MONTREAL, an island of North America, in the river St Lawrence, about 28 miles long and 10 broad. The soil is very fertile, and the air wholesome. It belonged to the French; but was taken by the generals Amherst and Murray on the 8th of September 1760,

without firing a gun. According to the terms of capitulation, all the French forces were to be sent to Old France; and, consequently, all Canada became subject to the crown of Great Britain; this cession was confirmed by the peace of 1763. The town is pretty well fortified; and has a pleasant situation, with wide open streets. It is built on the side of the river, from whence there is a gradual easy ascent to what is called the *Upper Town*. The Hôtel Dieu, the magazines, and the place of arms, are in the Lower Town; which is also the residence of the merchants. The seminary or school, the parish-church, the monks called *Rosollets*, the Jesuits, and the nuns, are in the Upper; where likewise the late governor, and most of the officers, resided. There are also a general hospital, and a church belonging to the Jesuits, which is large and well-built. The inhabitants carry on a trade with the savages in skins and furs. It is 120 miles south-west of Quebec, and 110 north of Albany. W. Long. 72. 4. N. Lat. 45. 35.

MONTROSE, a handsome town of North Britain, in the shire of Angus, situated at the mouth of the river Elk, on the German Ocean, 46 miles north-east of Edinburgh.

Steel spaws are very numerous in the country round Montrose. Besides these, there is a well near this town, whose water is of a whitish colour, soft taste, and faintly discovering a mineral quality, and is of a different nature from the steel one. It is universally diuretic; and has been found useful in stranguries, scorbutic disorders, flatulencies, &c.

MONTROSE (Marquis of). See GRAHAM; and BRITAIN, n° 137, 138, 143, 165.

MONTSERAT, an high mountain of Spain, in Catalonia, on which is a famous monastery and chapel, dedicated to the Virgin Mary, whose image is said to perform many miracles; so that numbers of pilgrims resort hither. It is inhabited by monks of several nations, who entertain all that come out of devotion or curiosity, for three days gratis. This mountain is said to be 10 miles in circumference, and five high, from the top of which there is a view of the country to the distance of 150 miles. It is 25 miles N. W. of Barcelona. E. Long 2. 35. N. Lat. 41. 40.

MONTSERRAT, one of the Caribbee Isles belonging to Great Britain. It is a very small, but very pleasant island, so called by Columbus from its resemblance to a famous mountain near Barcelona in Catalonia. It lies in W. Long. 61. o. N. Lat. 16. 50. having Antigua to the north-east, St Christopher's and Nevis to the north-west, and Guadalupe lying south south-east at the distance of about nine leagues. In its figure it is nearly round, about nine miles in extent every way, 27 in circumference, and is supposed to contain about 40,000 or 50,000 acres. The climate is warm, but less so than in Antigua, and is esteemed very healthy. The soil is mountainous, but with pleasant valleys, rich and fertile, between them; the hills are covered with cedars and other fine trees. Here are all the animals as well as vegetables and fruits that are to be found in the other islands, and not at all inferior them in quality. The inhabitants raised formerly a considerable quantity of indigo, which was none of the best, but which they cut four times a-year. The present product is cotton, rum, and sugar. There is no good harbour, but three to-  
leable

Montserrat lerable roads at Plymouth, Old Harbour, and Ker's-bay, where they ship the produce of the island. Public affairs are administered here as in the other isles, by a lieutenant-governor, council, and assembly, composed of no more than eight members, two from each of the four districts into which it is divided. The wonderful effects of industry and experience in meliorating the gifts of nature have been no where more conspicuous than in these islands, and particularly in this, by gradually improving their produce, more especially of late years, since the art of planting hath been reduced to a regular system, and almost all the defects of soil so thoroughly removed by proper management and manure, that, except from the failure of seasons, or the want of hands, there is seldom any fear of a crop. In 1770 there were exported from this island to Great Britain 167 bags of cotton, 1670l.; 740 hogheads of rum, 7400l. To Ireland 133 ditto, 1330l.; 4338 hogheads 232 tierces 202 barrels of sugar, 79,507l.; in the whole 89,907l. To North America 12,633l. There are a few ships employed in trading to this island from London and from Bristol. As to the number of inhabitants, according to the most probable accounts, they consist of between 1200 and 1500 whites, and from 10,000 to 12,000 negroes, tho' some say not so many.

**MONUMENT**, in architecture, a building destined to preserve the memory, &c. of the person who raised it, or the person for whom it was raised; such are a mausoleum, a triumphal arch, a pyramid, &c.

**MOOD**, or **MODE**. See **MODE**.

**Moods of Syllogism**. See **LOGIC**, n° 85.

**MOOD**, or **Mode**, in grammar, the different manner of conjugating verbs. See **GRAMMAR**.

**MOON**, in astronomy. See **ASTRONOMY**, *passim*.

**MOON-Word** in botany. See **LUNARIA**.

**MOOR**, in country affairs, denotes an unlimited tract of land, usually over-run with heath.

**MOOR-Cock**, or **GOR-cock**. See **TETRAO**.

**MOOR-Stone**, a valuable stone, much used in the coarser works of the present builders; being truly a white granite, of a marbly texture.

**MOORE**, or **MORE**, (Edward), a late ingenious writer, was bred a linen-draper, but quitted business to join the retinue of the mules; and he certainly had a very happy and pleasing talent for poetry. In his *Trial of Selim the Persian*, he complimented lord Lytelton in an elegant kind of panegyric, couched under the appearance of accusation: and his *Fables for the female sex*, for easy versification, poignant satire, and striking morals, approach nearer to the manner of Gay, than any other of the numerous imitations of that author. He wrote also three dramatic pieces; *The Gameller*, a tragedy; *The Foundling*, and *Gil Blas*, comedies. The success of these was not such as they merited; the first of them having met with a cold reception, for no other apparent reason but because it too nearly touched a favourite and fashionable vice; and the second having been condemned for its supposed resemblance to Sir Richard Steele's *Conscious Lovers*, but to which good judges have been inclined to give it greatly the preference. Mr Moore married a lady of the name of *Hamilton*, daughter to Mr Hamilton table-decker to the princesses; who had herself a very poetical turn, and has been said to have assisted him in the writing of his tragedy. One specimen of her

poetry, however, was handed about before their marriage, and has since appeared in print in different collections of songs, particularly in one called the *Gold-finch*. It was addressed to a daughter of the famous Stephen Duck; and begins with the following stanza:

Would you think it, my Duck, for the fault I must own,  
Your Jeremy, at last, is quite covetous grown:  
'Tho' millions if Fortune should lavishly pour,  
I still shou'd be wretched, if I had not **MORE**.

And after half a dozen stanzas more, in which, with great ingenuity and delicacy, and yet in a manner that expresses a sincere affection, she has quibbled on our author's name, she concludes with the following lines:

You will wonder, my girl, who this dear one can be,  
Whose merit can boast such a conquest as me:  
But you shan't know his name, tho' I told you before,  
It begins with an M, but I dare not say **MORE**.

In the year 1753, Mr Moore commenced a weekly miscellaneous paper, intitled *The World*, by *Adam Fitz-Adam*; in which undertaking he was assisted by lord Chesterfield with some essays. This paper was collected into volumes, and Mr Moore died soon after.

**MOORING**, the act of confining and securing a ship in a particular station, by chains or cables, which are either fastened to the adjacent shore, or to anchors in the bottom.

A ship may be either moored by the head, or by the head and stern: that is to say, she may be secured by anchors before her; without any behind; or she may have anchors out, both before and behind her; or her cables may be attached to posts, rings, or moorings, which answer the same purpose.

When a ship is moored by the head with her own anchors, they are disposed according to the circumstances of the place where she lies, and the time she is to continue therein. Thus wherever a tide ebbs and flows, it is usual to carry one anchor out towards the flood, and another towards the ebb, particularly where there is little room to range about; and the anchors are laid in the same manner, if the vessel is moored head and stern in the same place. The situation of the anchors, in a road or bay, is usually opposed to the reigning winds, or those which are most dangerous; so that the ship rides therein with the effort of both her cables. Thus if she rides in a bay, or road, which is exposed to a northerly wind and heavy sea from the fame quarter, the anchors passing from the opposite bows ought to lie east and west from each other: hence both the cables will retain the ship in her station with equal effort against the action of the wind and sea.

**MOOSE**, or **ELK**. See **CERVUS**.

**MOOT**, a difficult case argued by the young barristers and students at the inns of court, by way of exercise, the better to qualify them for practice, and to defend the causes of their clients. This, which is called *mooting*, is the chief exercise of the inns of court. Particular times are appointed for the arguing moot-cases: the place where this exercise is performed was anciently called *moot-hall*; and there is a bailiff, or surveyor of the moots, annually chosen by the bench, to appoint the moot-men for the inns of chancery, and to keep an account of the performance of exercises.—The word is formed either from the Saxon *metan, gemetan*, "meeting;" or from the French *mot, "word."*

Mooring  
||  
Moot.

## MORAL PHILOSOPHY, OR MORALS.

MORAL PHILOSOPHY is "The science of MAN-  
NERS OF DUTY; which it traces from man's  
nature and condition, and shews to terminate in his  
"happinefs." In other words, it is "The knowledge  
"of our DUTY and FELICITY;" or, "The art of be-  
"ing VIRTUOUS and HAPPY."

It is denominated an *art*, as it contains a system of rules for becoming virtuous and happy. Whoever practises these rules, attains an habitual power or facility of becoming virtuous and happy. It is likewise called a *science*, as it deduces those rules from the principles and conceptions of our nature, and proves that the observance of them is productive of our happiness.

It is an art, and a science, of the highest dignity, importance, and use. Its object is man's duty, or his conduct in the several moral capacities and connections which he sustains. Its office is to direct that conduct; to shew whence our obligations arise, and where they terminate. Its use, or end, is the attainment of happiness; and the means it employs are rules for the right conduct of our moral powers.

Moral Philosophy has this in common with Natural Philosophy, that it appeals to nature or fact; depends on observation; and builds its reasonings on plain uncontroverted experiments, or upon the fullest induction of particulars of which the subject will admit. We

must observe, in both these sciences, how nature is affected, and what her conduct is in such and such circumstances. Or, in other words, we must collect the appearances of nature in any given instance; trace these to some general principles, or laws of operation; and then apply these principles or laws to the explaining of other phenomena.

Therefore Moral Philosophy inquires, not how man might have been, but how he is, constituted: not into what principles or dispositions his actions may be artfully resolved; but from what principles and dispositions they actually flow: not what he may, by education, habit, or foreign influence, come to be, or do; but what, by his nature, or original constituent principles, he is formed to be and do. We discover the office, use, or destination of any work, whether natural or artificial, by observing its structure, the parts of which it consists, their connection or joint action. It is thus we understand the office and use of a watch, a plant, an eye, or hand. It is the same with a living creature, of the rational, or brute kind. Therefore, to determine the office, duty, or destination of man; or, in other words, what his business is, or what conduct he is obliged to pursue; we must inspect his constitution, take every part to pieces, examine their mutual relations one to the other, and the common effort or tendency of the whole.

## P A R T I.

## CHAP. I.

## Of Man and his CONNECTIONS.

MAN is born a weak, helpless, delicate creature, unprovided with food, clothing, and whatever else is necessary for subsistence or defence. And yet, exposed as the infant is to numberless wants and dangers, he is utterly incapable of supplying the former, or securing himself against the latter. But, though thus feeble and exposed, he finds immediate and sure resources in the affection and care of his parents, who refuse no labours, and forego no dangers, to nurse and rear up the tender babe. By these powerful instincts, as by some mighty chain, does nature link the parent to the child, and form the strongest moral connection on his part, before the child has the least apprehension of it. Hunger and thirst, with all the sensations that accompany or are connected with them, explain themselves by a language strongly expressive, and irresistibly moving. As the several senses bring in notices and informations of surrounding objects, we may perceive in the young spectator early signs of a growing wonder and admiration. Bright objects and striking sounds are beheld and heard with a sort of commotion and surprize. But, without resting on any, he eagerly passes on from object to object, still pleased with whatever is most new. Thus the love of novelty is

formed, and the passion of wonder kept awake. By degrees he comes acquainted with the most familiar objects, his parents, his brethren, and those of the family who are most conversant with him. He contracts a fondness for them, is uneasy when they are gone, and charmed to see them again. These feelings become the foundation of a moral attachment on his side, and by this reciprocal sympathy he forms the domestic alliance with his parents, brethren, and other members of the family. Hence he becomes interested in their concerns, and feels joy or grief, hope or fear, on their account, as well as his own. As his affections now point beyond himself to others, he is denominated a good or ill creature, as he stands well or ill affected to them. These then are the first links of the moral chain, the early rudiments, or outlines of his character, his first rude essays towards agency, freedom, manhood.

When he begins to make excursions from the nursery, and extends his acquaintance abroad, he forms<sup>2</sup> a little circle of companions, engages with them in play, or in quest of adventures, and leads, or is led by them, as his genius is more or less aspiring. Tho' this is properly the season in which appetite and passion have the ascendancy, yet his imagination and intellectual powers open apace; and as the various images of things pass before the mental eye, he forms va-

riety of tastes; relishes some things, and dislikes others, as his parents, companions, and a thousand other circumstances, lead him to combine agreeable or disagreeable sets of ideas, or represent to him objects in alluring or odious lights.

As his views are enlarged, his *active* and *social* powers expand themselves in proportion; the *love of action*, of *imitation*, and of *praise*; *emulation*, *curiosity*, *docility*, a *passion for command*, and *fondness of change*. His passions are quick, variable, and pliant to every impression; his attachments and disgusts quickly succeed each other. He compares things, distinguishes actions, judges of characters, and loves or hates them, as they appear well or ill affected to himself, or to those he holds dear. Mean while he soon grows sensible of the consequences of his own actions, as they attract applause, or bring contempt; he triumphs in the former, and is ashamed of the latter; wants to hide them, and blushes when they are discovered. By means of these powers he becomes a fit subject of culture, the moral tie is drawn closer, he feels that he is accountable for his conduct to others as well as to himself, and thus is gradually ripening for society and action.

3  
His youth.

As man advances from *childhood* to *youth*, his passions as well as perceptions take a more extensive range. New senses of pleasure invite him to new pursuits; he grows sensible to the attractions of beauty, feels a peculiar sympathy with the sex, and forms a more tender kind of attachment than he has yet experienced. This becomes the cement of a *new moral relation*, and gives a softer turn to his passions and behaviour. In this turbulent period he enters more deeply into a *recluse of friendships*, *company*, *exercises*, and *diversions*; the *love of truth*, of *imitation*, and of *design*, grows upon him; and as his connections spread among his neighbours, fellow-citizens, and country-men, his *thirst of praise*, *emulation*, and *social affections* grow more intense and active. Mean while, it is impossible for him to have lived thus long without having become sensible of those more august signatures of order, wisdom, and goodness, which are stamped on the visible creation; and of those strong suggestions within himself of a parent-mind, the source of all intelligence and beauty; an object as well as source of that activity, and those aspirations which sometimes rouse his inmost frame, and carry him out of himself to an almighty and all-governing power: Hence arise those sentiments of *reverence*, and those affections of *gratitude*, *resignation*, and *love*, which link the soul with the Author of Nature, and form that most sublime and god-like of all connections.

4  
His manhood.

Man having now reached his prime, either new passions succeed, or the old set are wound up to a higher pitch. For, growing more sensible of his connections with the public, and that particular community to which he more immediately belongs; and taking withal a larger prospect of human life, and its various wants and enjoyments; he forms more intimate friendships, grasps at power, courts honour, lays down cooler plans of interest, and becomes more attentive to the concerns of society; he enters into family connections, and indulges those charities which arise from thence. The *reigning* passions of this pe-

riod powerfully prompt him to provide for the decays of life; and in it *compassion* and *gratitude* exert their influence in urging the *man*, now in full vigour, to requite the affection and care of his parents, by supplying their wants and alleviating their infirmities.

At length human life verges downwards; and old age creeps on apace, with its *anxiety*, *love of ease*, *interestedness*, *fearfulness*, *fore-sight*, and *love of offspring*. The experience of the aged is formed to direct, and their coolness to temper, the heat of youth; the former teaches them to look back on past follies, and the latter to look forward into the consequences of things, and provide against the worst. Thus every age has its peculiar genius and set of passions corresponding to that period, and most conducive to the prosperity of the rest. And thus are the *wants* of one period supplied by the *capacities* of another, and the *weaknesses* of one age tally to the *passions* of another.

Besides these, there are other passions and affections of a less *ambulatory* nature, not peculiar to one period, but belonging to every age, and acting more or less in every breath throughout life. Such are *self-love*, *benevolence*, *love of life*, *honour*, *shame*, *hope*, *fear*, *desire*, *aversion*, *joy*, *sorrow*, *anger*, and the like. The two first are affections of a cooler strain, one pointing to the good of the individual, the other to that of the species; *joy* and *sorrow*, *hope* and *fear*, seem to be only modifications, or different exertions, of the same original affections of *love* and *hatred*, *desire* and *aversion*, arising from the different circumstances or position of the object desired or abhorred, as it is present or absent. From these likewise arise other *secondary* or *occasional* passions, which depend, as to their existence and several degrees, upon the original affections being gratified or disappointed, as *anger*, *complacence*, *confidence*, *jealousy*, *love*, *hatred*, *dejection*, *exaltation*, *contentment*, *disgust*, which do not form leading passions, but rather hold of them.

By these simple but powerful springs, whether *periodical* or *fixed*, the life of man, weak and indigent as he is, is preserved and secured, and the creature is prompted to a constant round of action, even to supply his own numerous and ever-returning *wants*, and to guard against the various *dangers* and *evils* to which he is obnoxious. By these links men are connected with each other, formed into families, drawn into particular communities, and all united as by a common league into one system or body, whose members feel and sympathize one with another. By this admirable adjustment of the constitution of *man* to his *state*, and the gradual evolution of his powers, order is maintained, society upheld, and human life filled with that variety of passion and action which at once enliven and diversify it.

This is a short sketch of the *principal movements* of the human mind. Yet, these movements are not the *recting* whole of man; they impel to action, but do not direct it; they need a *regulator* to guide their motions, to measure and apply their forces; and accordingly they have one that naturally *superintends* and *directs* their action. We are conscious of a principle within us, which examines, compares, and weighs things, notes the differences, observes the forces, and foresees the consequences of affections and actions. By this

5  
Old age.

6

Passions of every age.

7

Their joint effects.

8

The directing power.

this power we look back on past times, and forward into futurity, gather experiences, estimate the real and comparative value of objects, lay out schemes, contrive means to execute them, and settle the whole order and œconomy of life. This power we commonly distinguish by the name of *reason* or *reflection*, the business of which is not to suggest any original notions or sensations, but to canvass, range, and make deductions from them.

9  
The judging or approving powers.

We are intimately conscious of another principle within us, which approves of certain *sentiments, passions, and actions*, and disapproves of their contraries. In consequence of the decisions of this inward judge, we denominate some actions and principles of conduct *right, honest, good*; and others *wrong, dishonest, ill*. The former excite our *esteem, moral complacence, and affection*, immediately and originally of themselves, without regard to their consequences, and whether they affect our interest or not. The latter do as naturally and necessarily call forth our *contempt, scorn, and aversion*. That power by which we perceive this difference in affections and actions, and feel a consequent relish or dislike, is commonly called *conscience* or the *moral sense*. Whether such a power belongs to human nature or not, must be referred to every one's experience of what passes within himself.

10  
These powers differ from affections.

These two powers of *reason* and *conscience* are evidently principles different in *nature* and *kind* from the passions and affections. For the passions are mere *force or power, blind impulses*, acting violently and without choice, and ultimately tending each to their respective objects, without regard to the interest of the others, or of the whole system. Whereas the *directing and judging powers* distinguish and ascertain the different forces, mutual proportions and relations, which the passions bear to each other and to the whole; recognize their several degrees of merit, and judge of the whole temper and conduct, as they respect either the individual or the species; and are capable of directing or restraining the blind impulses of passion in a due consistency one with the other, and a regular subordination to the whole system.

11  
Division of the passions.

This is some account of the *constituent principles* of our nature, which, according to their different mixtures, degrees, and proportions, mould our character and sway our conduct in life. In reviewing that large train of affections which fill up the different stages of human life, we perceive this obvious distinction among them; that some of them respect the *good of the individual*, and others carry us beyond ourselves to the *good of the species or kind*. The former have therefore been called *private*, and the latter *public affections*. Of the first sort are, *love of life, of pleasure, of power, and the like*. Of the last are *compassion, gratitude, friendship, natural affection*, and the like. Of the *private passions*\*, some respect merely the *security and defence* of the creature, such as *resentment and fear*; whereas others aim at some *positive advantage or good, as wealth, ease, fame*. The former sort therefore, because of this difference of objects, may be termed *defensive* passions. These answer to our *dangers*, and prompt us to avoid them if we can, or boldly to encounter them when we cannot.

12  
Defensive passions.

The other class of *private* passions, which pursue *private positive good*, may be called *appetitive*. However, we shall still retain the name of *private*, in contradistinction to the *defensive* passions. Man has a great variety of wants to supply, and is capable of many enjoyments, according to the several periods of his life, and the different situations in which he is placed. To these therefore a suitable train of *private* passions correspond, which engage him in the pursuit of whatever is necessary for his subsistence or welfare.

13  
Private or appetitive passions.

Our *public or social* affections are adapted to the several *social connections and relations* which we bear to others, by making us sensible of their dangers, and interesting us in their wants, and so prompting us to secure them against one and supply the other.

14  
Public passions.

This is the first step then to discover the *duty and destination* of man, the having analysed the principles of which he is composed. It is necessary, in the next place, to consider in what order, *proportion, and measure* of those inward principles, *virtue*, or a sound moral temper and right conduct consists; that we may discover whence *moral obligation* arises.

## CHAP. II.

### Of DUTY, or MORAL OBLIGATION.

It is by the end or design of any power or movement that we must direct its motions, and estimate the degree of force necessary to its just action. If it wants the force requisite for the obtaining its end, we reckon it defective; if it has too much, so as to be carried beyond it, we say it is overcharged; and in either case it is imperfect and ill-conformed. If it has just enough to reach the scope, we esteem it right and as it should be. Let us apply this reasoning to the passions.

15  
The measure of powers.

The *defence and security* of the individual being the *aim of the defensive passions*, that *security and defence* must be the *measure of their strength or indulgence*. If they are so *weak* as to prove insufficient for that end, or if they *carry us beyond it*, i. e. raise unnecessary commotions, or continue longer than is needful, they are unfit to answer their original design, and therefore are in an unsound and unnatural state. The exercise of *fear* or of *resentment* has nothing desirable in it, nor can we give way to either without painful sensations. Without a certain degree of them, we are naked and exposed. With too high a proportion of them, we are miserable, and often injurious to others. Thus *cowardice or timidity*, which is the excess of fear, instead of saving us in danger, gives it too formidable an appearance, makes us incapable of attending to the best means of preservation, and disarms us of *courage*, our natural armour. *Fool-hardiness*, which is the want of a due measure of *fear*, leads us heedlessly into danger, and lulls us into a pernicious security. *Revenge*, i. e. *excessive resentment*, by the violence of its commotion, robs us of that *presence of mind* which is often the best guard against injury, and inclines us to pursue the aggressor with more severity than self-defence requires. *Pusillanimity*, or the want of a just indignation against wrong, leaves us quite unguarded, and tends to sink the mind into a passive

16  
Measure of the defensive passions.

\* Here we use passions and affections without distinction. Their difference will be marked afterwards.

enervated tamenefs. Therefore "To keep the de-  
" fenfive paffions duly proportioned to our dangers,  
" is their natural pitch and tenor."

17  
Measure of  
the private  
paffions.

"The *private* paffions lead us to purfue fome *pos-  
fible* fpecies of *private* good: that good therefore  
which is the object and end of each muft be the *mea-  
fure* of their refpective force, and direct their opera-  
tion. If they are too *weak* or *fluggifh* to engage us  
in the purfuit of their feveral objects, they are evi-  
dently *deficient*; but if they defeat their end by their  
*impetuofity*, then are they ftrained beyond the juft  
tone of nature. Thus *vanity*, or an *exceffive* paffion  
*for applaufe*, betrays into fuch meannefses and little  
arts of popularity as makes us forfeit the honour we  
fo anxiously court. On the other hand, a *total* dif-  
*ference* about the *eftem* of mankind removes a ftrong  
guard and fpur to virtue, and lays the mind open to the  
moft abandoned profeffions. Therefore, "to keep  
" our private paffions and defires proportioned to our  
" wants, is the juft meafure and pitch of this clafs of  
" affections."

18  
Comparative  
force.

The *defenfive* and *private* paffions do all agree in  
general, in their tendency or conduciveness to the in-  
tereft or good of the individual. Therefore, when  
there is a collision of intereft, as may fometimes hap-  
pen, that *aggregate of good* or *happinefs*, which is  
compofed of the particular goods to which they re-  
fpectively tend, muft be the common ftandard by  
which their *comparative degrees* of ftrength are to be  
meafured: that is to fay, if any of them, in the de-  
gree in which they prevail, are incompatible with the  
greateft aggregate of good or moft extenfive intereft  
of the individual, then are they unequal and difpro-  
portionate. For, in judging of a particular *fyftem* or  
*conftitution* of powers, we call that the *fyftem* or  
*principal end* in which the aims of the feveral parts or  
powers coincide, and to which they are fubordinate;  
and reckon them in due proportion to each other, and  
right with regard to the whole, when they maintain  
that fubordination of fubferviency. Therefore, "To  
" proportion our defenfive and private paffions in fuch  
" meafure to our dangers and wants as beft to fecure  
" the individual, and obtain the greateft aggregate of  
" private good or happinefs, is their juft balance or  
" comparative ftandard in cafe of competition."

19  
Measure of the  
public  
affections.

In like manner as the *public* or *fyftem* affections point  
at the good of others, that *good* muft be the meafure  
of their force. When a particular *fyftem* affec-  
tion, as *gratitude* or *friendfhip*, which belongs to a particular  
*fyftem* connection, viz. that of a *benefactor* or of a  
*friend*, is too feeble to make us act the *grateful* or  
*friendly* part, that affection, being infufficient to anfwer  
its end, is *defective* and *unfounded*. If, on the other  
hand, a particular paffion of this clafs counteract or de-  
feat the intereft it is defigned to promote, by its vio-  
lence or difproportion, then is that paffion *exceffive*  
and *irregular*. Thus *natural affection*, if it dege-  
nerates into a *paflionate* fondnefs, not only hinders the  
parents from judging coolly of the intereft of their  
offspring, but often leads them into a moft partial and  
pernicious indulgence.

20  
Collision of  
focial affec-  
tions.

As every kind affection points at the good of its par-  
ticular object, it is poffible there may be fometimes a  
collision of interefts or goods. Thus the regard due

to a *friend* may interfere with that which we owe to  
a *community*. In fuch a competition of interefts, it  
is evident that the *greateft* is to be chofen; and that  
is the greateft intereft which contains the greateft fun  
or aggregate of public good, greateft in *quantity* as  
well as *duration*. This then is the *common ftandard*  
by which the refpective forces and fubordinations of  
the focial affections muft be adjusted. Therefore we  
conclude, that "This clafs of affections are found and  
" regular when they prompt us to purfue the *intereft*  
" of individuals in an intire confiftency with the *pub-  
lic good*," or, in other words, "When they are duly  
" proportioned to the dangers and wants of others,  
" and to the various relations in which we ftand to  
" individuals or to *fociety*."

Thus we have found, by an induction of particulars,  
the *natural pitch* or *tenor* of the *different orders* of  
affection, confidered apart by themfelves. Now as the  
*virtue* or *perfection* of every creature lies in fol-  
lowing its nature, or acting fuitably to the juft pro-  
portion and harmony of its feveral powers; there-  
fore, "The *VIRTUE* of a creature endowed with fuch  
" affections as *man* muft confift in obferving or acting  
" agreeably to their *natural pitch* and *tenor*."

But, as there are no independent affections in the  
fabric of the mind, no paffion that ftands by itfelf,  
without fome relation to the reft, we cannot pro-  
nounce of any one, confidered APART, that it is either  
*too ftrong* or *too weak*. Its ftrength and juft pro-  
portion muft be meafured not only by its fubferviency  
to its own immediate end, but by the refpect it bears to  
the whole fyftem of affection. Therefore, we fay a  
paffion is *too ftrong*, not only when it defeats its own  
end, but when it impairs the force of other paffions,  
which are equally neceffary to form a *temper* of mind  
fitted to a certain *economy* or *ftate*; and too weak,  
not merely on account of its infufficiency to anfwer  
its end, but becaufe it cannot fuftain its *part* or *office*  
in the balance of the whole fyftem. Thus the *love*  
of *lf*: may be *too ftrong* when it takes from the *re-  
gard* due to one's country, and will not allow one  
bravely to encounter dangers, or even death on its  
account. Again, the *love* of *fame* may be *too weak*  
when it throws down the fences which render virtue  
more fecure, or weakens the incentives which make  
it more active and public-fpirited.

If it be afked, "How far may the affections to-  
wards private good or happinefs be indulged?"  
One limit was before fixed for the particular in-  
dulgence of each, viz. their fubordination to the common  
aggregate of good to the private fyftem. In thefe  
therefore a due regard is always fuppofed to be had  
to *health*, *reputation*, *fortune*, the *freedom* of action,  
the *unimpaired exercife* of *reafon*, the *calm enjoy-  
ment* of *one's felf*, which are all private goods. An-  
other limit now results from the balance of affection  
juft named, viz. "The *fecurity* and *happinefs* of  
others;" or, to exprefs it more generally, "a *private*  
affection may be fafely indulged, when, by that in-  
dulgence, we do not violate the obligations which re-  
fult from our higher relations or public connections."  
A juft refpect therefore being had to thefe boundaries  
which nature has fixed in the breaft of every man,  
what fhould limit our purfuits of private happinefs?  
Is

21  
Balance of  
affection.

22  
Limits of  
private af-  
fections.

Is nature fullen and penurious? Or does the God of nature envy the happiness of his offspring?

[ 22 ]  
Collision of  
interests.

Whether there is ever a real collision of interests between the *public* and *private* system of affections, or the *ends* which each class has in view, will be afterwards considered; but where there is no collision, there is little or no danger of carrying either, but especially the *public* affections, to excess, provided both kinds are kept subordinate to a discreet and cool *self-love*, and to a calm and universal *benevolence*, which principles stand as guards at the head of each system.

23  
Result.

This then is the conduct of the passions, considered as *particular* and *separate* forces, carrying us out to their respective ends; and this is their balance or *economy*, considered as *compound* powers, or powers mutually related, acting in conjunction towards a *common* end, and consequently as forming a *system* or *whole*.

24  
Subordination  
of powers.

Now, whatever adjusts or maintains this *balance*, whatever in the human constitution is formed for *directing* the passions so as to keep them from defeating their own end or interfering with each other, must be a principle of a *superior* nature to them, and ought to direct their measures and govern their proportions. But it was found that *reason* or *reflection* is such a principle, which points, out the tendency of our passions, weighs their influence upon private and public happiness, and shews the best means of attaining either. It having been likewise found that there is another directing or controlling principle, which we call *CONSCIENCE* or the *MORAL SENSE*, which, by a native kind of authority, judges of affections and actions, pronouncing some *just* and *good*, and others *unjust* and *ill*; it follows that the passions, which are mere impulse or blind forces, are principles inferior and subordinate to this *judging* faculty. Therefore, we would follow the order of nature, *i. e.* observe the mutual respects and the subordination which the different parts of the human constitution bear one to another, the passions ought to be subjected to the direction and authority of the *leading* or *controlling* principles.

25  
In what it  
consists.

We conclude therefore, from this *induction*, that "the *constitution* or *just economy* of human nature consists in a regular *subordination* of the *passions* and "affections to the *authority* of *conscience* and the *direction* of *reason*."

26  
Economy  
of nature,  
or right  
temper.

That *subordination* is *regular*, when the proportion formerly mentioned is maintained; that is to say, "When the *defensive* passions are kept proportioned to our *dangers*; when the *private* passions are proportioned to our *wants*; and when the *public* affections are adapted to our *public connections*, and proportioned to the wants and dangers of "others."

27  
Human vir-  
tue and per-  
fection.

But the *natural state*, or the *sound* and *vigorous* constitution of any creature, or the *just economy* of its powers, we call its *health* and *perfection*; and the acting agreeably to these, its *virtue* or *goodness*. Therefore, "the *health* and *perfection* of man must lie in the *aforsaid supremacy* of *conscience* and *reason*, and in the *subordination* of the passions to their "authority and *direction*. And his *virtue* or *goodness*

"must consist in acting agreeably to that *order* or "economy."

28  
How con-  
formable to  
reason.

That such an ornament of the mind, and such a conduct of its powers and passions, will stand the test of *reason*, cannot admit of any dispute. For, upon a fair examination into the consequences of things, or the relations and aptitudes of means to ends, *reason* evidently demonstrates, and *experience* confirms it, that, "To have our *defensive* passions duly proportioned to our *dangers*, is the surest way to avoid or get clear of them, and obtain the security we seek after.—To proportion our *private* "passions to our *wants*, is the best means to supply them;—and, to adapt our *public affections* to "our *social relations*, and the *good* of others, is the "most effectual method of fulfilling one, and procuring the other." In this sense, therefore, *virtue* may be said to be a "conduct conformable to *reason*," as *reason* discovers an apparent *aptitude*, in such an *order* and *economy* of powers and passions, to answer the end for which they are *naturally* formed.

If the idea of *moral obligation* is to be deduced merely from this *aptitude* or *connection* between certain passions, or a certain order and balance of passions, and certain ends obtained or to be obtained by them, then is *reason* or *reflection*, which perceives that aptitude or connection, the proper judge of *moral obligation*; and on this supposition it may be defined, as hath been done by some, the connection between the *affection* and the *end*, or, which is the same thing, between the *action* and the  *motive*; for the *end* is the  *motive* or the  *final cause*, and the *affection* is the  *action*, or its immediate natural cause. A man, from mere *self-love*, may be induced to fulfil that obligation which is founded on the connection between the *defensive* passions and their *ends*, or the *private* passions and their *ends*; because in that case his own interest will prompt him to indulge them in the due proportion required. But if he has no affections which point beyond himself, no principle but *self-love*, or some subtle modification of it, what shall interest him in the happiness of others, where there is no connection between it and his own; or what sense can he have of *moral obligation* to promote it? upon this scheme, therefore, without public or social affection there could be no  *motive*, and consequently no moral obligation, to a beneficial disinterested conduct.

29  
Connection  
between af-  
fections and  
ends, not  
the idea of  
moral obli-  
gation.

But if the mere connection between certain passions, or a certain order of passions and certain ends, are what constitutes or gives us the idea of *moral obligation*, then why may not the apportionness of any temper or conduct, nay, of any piece of machinery to obtain its end, form an equally strict *moral obligation*? for the connection and aptitude are as strong and invariable in the latter instances as in the former. But as this is confounding the most obvious differences of things, we must trace the idea of *moral obligation* to another and a more natural source.

Let us appeal, therefore, to our *innost* sense and experience, "how we stand affected to those different sets of passions, in the just measure and balance of virtue, "which we found a right temper to consist." For this is entirely a matter of experience, in which we

30  
Idea of it  
from expe-  
rience.

must

must examine, as in any other natural inquiry, "what are the genuine feelings and operations of nature, and what affections or symptoms of them appear in the given instance."

31  
Why the  
defensive  
passions are  
proved.

The defensive passions, as *anger* and *fear*, give us rather pain than pleasure, yet we cannot help feeling them when provoked by injury, or exposed to harm. We account the creature imperfect that wants them, because they are necessary to his defence. Nay, we should in some measure condemn ourselves, did we want the necessary degree of *resentment* and *caution*. But if our *resentment* exceeds the wrong received, or our *caution* the evil dreaded, we then blame ourselves for having over-acted our part. Therefore, while we are in danger to be totally destitute of them we reckon a *blameable defect*, and to feel them in a just, *i. e.* necessary measure, we *approve*, as suited to the nature and condition of such a creature as man. But our security obtained, to continue to indulge them, we not only *disapprove* as *hurtful*, but *condemn* as *unmanly*, *unbecoming*, and *mean-spirited*: Nor will such a conduct afford any self-approving joy when we coolly reflect upon it.

32  
Why the  
private.

With regard to the *private* passions, such as *love of life*, *pleasure*, *ease*, and the like, as these aim at private good, and are necessary to the perfection and happiness of the individual, we should reckon any creature *defective*, and even *blameable*, that was destitute of them. Thus, we condemn the man who imprudently ruins his fortune, impairs his health, or exposes his life; we not only pity him as an unfortunate creature, but feel a kind of *moral indignation* and contempt of him, for having made himself such. On the other hand, though a discreet self-regard does not attract our esteem and veneration, yet we approve of it in some degree, in an higher and different degree from what we would regard a well-contrived machine, as necessary to constitute a finished creature, nay, to complete the virtuous character, as exactly suited to our present indigent state. There are some passions respecting private good, towards which we feel higher degrees of approbation, as the *love of knowledge*, of *action*, of *honour*, and the like. We esteem them as marks of an ingenuous mind, and cannot help thinking the character in which they are wanting remarkably stupid, and in some degree *immoral*.

33  
Why the  
public.

With regard to the social affections, as *compassion*, *natural affection*, *friendship*, *benevolence*, and the like, we approve, admire, and love them in ourselves, and, in all in whom we discover them, with an esteem and approbation, if not different in kind, yet surely far superior in degree, to what we feel towards the other passions. These we reckon necessary, just, and excellently fitted to our structure and state; and the creature which wants them we call *defective*, ill-constituted, a kind of abortion. But the *public* affections we esteem as self-worthy, originally and eternally amiable.

34  
Distinction  
between ve-  
hement and  
calm affec-  
tions.

But among the *social* affections we make an obvious and constant distinction, *viz.* between those particular passions which urge us with a sudden violence, and uneasy kind of sensation, to pursue the good of their respective objects, as *pity*, *natural affection*, and the like; and those calm dispassionate affections and de-

fires which prompt us more steadily and uniformly to promote the happiness of others. The former we generally call *passions*, to distinguish them from the other sort, which go more commonly by the name of *affections*, or *calm desires*. The first kind we approve indeed, and delight in; but we feel still higher degrees of approbation and moral complacency towards the *last*, and towards all limitation of the particular instincts, by the principle of *universal benevolence*. The more objects the calm affections take in and the worthier these are, their dignity rises in proportion, and with this our approbation keeps an exact pace. A character, on the other hand, which is quite divested of these public affections, which feels no love for the species, but instead of it entertains malice, rancour, and ill-will, we reckon totally immoral and unnatural.

Such then are the sentiments and dispositions we feel when these several orders of affection pass before the mental eye.

35  
Moral obli-  
gation.

Therefore, "that state in which we feel ourselves moved, in the manner above described, towards those affections and passions, as they come under the mind's review, and in which we are, instantaneously and independently of our choice or volition, prompted to a *correspondent* conduct, we call a state of *moral obligation*." Let us suppose, for instance, a parent, a friend, a benefactor, reduced to a condition of the utmost indigence and distress, and that it is in our power to give them immediate relief. To what conduct are we *obliged*? What duty does nature dictate and require in such a case? Attend to nature, and nature will tell, will tell with a voice irresistibly audible and commanding to the *human heart*, with an authority which no man can silence without being self-condemned, and which no man can elude but at his peril: "That immediate relief *ought* to be given." Again, let a friend, a neighbour, or even a stranger, have lodged a *deposit* in our hands, and after some time reclaim it, no sooner do these ideas of the confidence reposed in us, and of property not *transferred*, but *deposited*, occur, than we immediately and unavoidably feel and recognize the *obligation* to restore it. In both these cases we should condemn and even loathe ourselves if we acted otherwise, as having done, or omitted doing, what we *ought* not, as having acted beneath the dignity of our nature;—contrary to our most intimate sense of *right* and *wrong*:—we should accuse ourselves as guilty of ingratitude, injustice, and inhumanity,—and be conscious of deserving the censure, and therefore dread the resentment, of all rational beings.—But in complying with the *obligation*, we feel joy and self-approbation,—are conscious of an inviolable harmony between our nature and duty, and think ourselves intitled to the applause of every impartial spectator of our conduct.

36  
Moral obli-  
gation.

To describe therefore what we cannot perhaps *define*, a state of *moral obligation* is "that state in which a creature, endowed with such senses, powers, and affections of man, would condemn himself, and think he deserved the condemnation of all others, should he refuse to fulfil it; but would approve himself, and expect the approbation of all others, upon complying with it."



37  
Moral action.

And we call him a MORAL AGENT, who is in such a state, or is subject to moral obligation. Therefore, as man's *structure and connections* often subject him to such a state of moral obligation, we conclude that he is a moral agent. But as man may sometimes act without knowing what he does, as in cases of *frenzy or disease*, or in many *natural functions*; or, knowing what he does, he may act without choice or affection, as in cases of *necessity or compulsion*; therefore to denominate an action *moral*, i. e. *approvable, or blameable*, it must be done *knowingly and willingly, or from affection and choice*. "A morally good action then is to fulfil a moral obligation knowingly and willingly." And a *morally bad action*, or an *immoral action*, is, "to violate a moral obligation knowingly and willingly."

38  
Moral action good and bad.

As not an action, but a *series of actions*, constitute a character; as not an affection, but a *series of affections*, constitute a temper; and as we denominate things by the *gross, & fortiori*, or by the qualities which chiefly prevail in them; therefore we call that a "morally good character, in which a *series of morally good actions* prevail;" and that a "morally good temper, in which a *series of morally good affections* have the ascendant." A bad character and bad temper are the reverse. But where the above mentioned *order or proportion* of passions is maintained, there a *series of morally good affections and actions* will prevail. Therefore, "to maintain that order and proportion, is to have a *morally good temper and character*." But a "morally good temper and character is *moral rectitude, integrity, virtue, or the completion of duty*."

40  
How we come by the idea of moral obligation.

If it be asked, after all, "how we come by the idea of moral obligation or duty?" We may answer, that we come by it in the same way as by our other *original and primary* perceptions. We receive them all from nature, or the great Author of nature. For this idea of moral obligation is not a creature of the mind, or dependent on any previous act of volition, but arises on certain occasions, or when certain other ideas are presented to the mind, as necessarily, instantaneously, and unavoidably, as *pain* does upon too near an approach to the fire, or *pleasure* from the fruition of any good. It does not, for instance, depend on our choice, whether we shall feel the obligation to succour a distressed parent, or to restore a deposit intrusted to us when it is recalled. We cannot call this a *compound idea* made up of one or more simple ideas. We may indeed, nay we must, have some ideas antecedent to it, e. g. that of a parent—in distress—of a child—able to relieve—of the relation of one to the other—of a trust—of right, &c. But none of these ideas constitute the perception of obligation. This is an idea quite distinct from, and something superadded to, the ideas of the correlatives, or the relation subsisting between them. These indeed, by a law of our nature, are the occasion of suggesting it; but they are as totally different from it as colours are from sounds. By sense of reflection we perceive the correlatives, our memory recalls the favours or deposit we received, the various circumstances of the case are matters of fact or experience; but some delicate inward *organ* or *power*, or call it what we please,

does, by a certain instantaneous sympathy, antecedent to the cool deductions of reason, and independent of previous instruction, art, or volition, perceive the *moral harmony, the living, irresistible charms of moral obligation*, which immediately interests the correspondent passions, and prompts us to fulfil its awful dictates.

We need not apprehend any danger from the quickness of its decisions, nor be frightened because it looks like *instinct*, and has been called so. Would we approve one for deliberating long, or reasoning the matter much at leisure, whether he should relieve a distressed parent, feed a starving neighbour, or restore the trust committed to him? should we not suspect the reasoner of knavery, or of very weak affections to virtue? we employ *reason*, and worthily employ it, in examining the condition, relations, and other circumstances of the agent or patient, or of those with whom either of them are connected, or, in other words, the *state of the case*: and in complicated cases, where the circumstances are many, it may require no small attention to find the true state of the case; but when the relations of the agent or patient, and the circumstances of the action are obvious, or come out such after a fair trial, we should scarce approve him who demurs on the obligation to that conduct which the case suggests.

From what has been said it is evident, that it is not the pleasure or agreeable sensations which accompany the exercise of the several affections, nor those consequent to the actions, that constitute *moral obligation*, or excite in us the idea of it. That pleasure is posterior to the idea of obligation, and frequently we are obliged, and acknowledge ourselves under an obligation, to such affections and actions as are attended with pain; as in the trial of virtue, where we are obliged to sacrifice private to public good, or a present pleasure to a future interest. We have pleasure in serving an aged parent, but it is neither the perception nor prospect of that pleasure which gives us the idea of obligation to that conduct.

## CHAP. III.

## The FINAL Causes of our moral Faculties of PERCEPTION and AFFECTION.

We have now taken a general prospect of MAN and the survey of his *moral powers and connections*, and on these Proposed-erected a scheme of duty, or moral obligation, which seems to be confirmed by *experience*, consonant to *reason*, and approved by his most inward and most sacred *senses*. It may be proper in the next place to take a more particular view of the *final causes* of those delicate *springs* by which he is impelled to action, and of those *clogs* by which he is restrained from it. By this detail we shall be able to judge of their aptitude to answer their end, in a creature endued with his *capabilities*, subject to his *wants*, exposed to his *dangers*, and susceptible of his *enjoyments*; and from thence we shall be in a condition to pronounce concerning the end of his *whole structure, its harmony with its state*, and consequently its subserviency to answer the great and benevolent intentions of its author.

The supreme Being has seen fit to blend in the whole of things a prodigious variety of discordant and contrary

41  
The use of reason in moral cases.42 [52]  
Pleasure, not the idea of obligation.53  
Proposed.

contrary

[53] Inward anatomy of the mind. contrary principles, *light and darkness, pleasure and pain, good and evil*. There are multifarious natures, *higher and lower*, and many intermediate ones between the wide-distant extremes. These are differently situated, variously adjusted, and subjected to each other, and all of them subordinate to the order and perfection of the whole. We may suppose *man* placed as in a centre amidst those innumerable orders of beings, by his *outward* frame drawing to the *material* system, and by his *inward* connected with the *INTELLECTUAL or moral*, and of course affected by the laws which govern both, or affected by that good and that ill which result from those laws. In this infinite variety of *relations* with which he is surrounded, and of *contingencies* to which he is liable, he feels strong attractions to the *good*, and violent repulsions or aversions to the *ill*. But as good and ill are often blended, and wonderfully complicated one with the other; as they sometimes immediately produce and run up into each other, and at other times lie at great distances, yet by means of intervening links introduce one another; and as these effects are often brought about in consequence of hidden relations and general laws, of the energy of which he is an incompetent judge, it is easy for him to mistake *good* for *evil*, and *evil* for *good*, and consequently he may be frequently attracted by such things as are destructive, or repel such as are salutary. Thus, by the tender and complicated frame of his body, he is subjected to a great variety of *ills*, to *sickness, cold, heat, fatigue*, and innumerable *wants*. Yet his knowledge is so narrow withal, and his reason so weak, that in many cases he cannot judge, in the way of investigation or reasoning, of the connections of those effects with their respective causes, or of the various latent energies of natural things. He is therefore informed of this connection by the experience of certain *senses or organs of perception*, which, by a mechanical instantaneous motion, feel the *good and the ill*, receiving pleasure from *one*, and pain from the *other*. By these, without any reasoning, he is taught to attract or chuse what tends to his welfare, and to repel and avoid what tends to his ruin. Thus, by his senses of *taste and smell*, or by the *pleasure* he receives from certain kinds of food, he is admonished which agree with his constitution, and by an opposite sense of *pain* he is informed which sorts disagree, or are destructive of it; but is not by means of this instructed in the inward natures and constitutions of things.

54  
Use of appetites and passions.

Some of those senses are armed with strong degrees of *unconsciousness or pain*, in order to urge him to seek after such objects as are suited to them. And these respect his more immediate and pressing *wants*; as the sense of *hunger, thirst, cold*, and the like; which, by their painful importunities, compel him to provide *food, drink, raiment, shelter*. Those instincts by which we are thus prompted with some kind of commotion or violence to attract and pursue *good*, or to repel and avoid *ill*, we call *appetites and passions*. By our senses then we are informed of what is *good or ill* to the *private system, or the individual*; and by our *private appetites and passions* we are impelled to one, and restrained from the other.

In consequence of this machinery, and the great

train of wants to which our nature subjects us, we are engaged in a continued series of occupations, which often require much application of thought, or great bodily labour, or both. The necessities of life, food, cloaths, shelter, and the like, must be provided; conveniencies must be acquired to render life still more easy and comfortable. In order to obtain these, arts, industry, manufactures, and trade, are necessary. And to secure to us the peaceable enjoyment of their fruits, civil government, policy, and laws, must be contrived, and the various business of public life carried on: thus while man is concerned and busied in making provision, or obtaining security for himself, he is by degrees engaged in connections with a family, friends, neighbours, a community, or a commonwealth. Hence arise new wants, new interests, new cares, and new employments. The passions of one man interfere with those of another. Interests are opposed. Competitions arise, contrary courses are taken. Disappointments happen, distinctions are made, and parties formed. This opens a vast scene of distraction and embarrassment, and introduces a mighty train of good and ill, both public and private. Yet amidst all this confusion and hurry, plans of action must be laid, consequences foreseen or guarded against, inconveniencies provided for; and frequently particular resolutions must be taken, and schemes executed, without reasoning or delay.

Now what provision has the Author of our nature made for this necessitous condition? How has he fitted for it the actor, man, for playing his part in this perplexed and busy scene?

Our supreme Parent, watchful for the whole, has not left himself without a witness here neither, and hath made nothing imperfect, but all things are double one against another. He has not left man to be informed, only by the cool notices of reason, of the *good or ill, the happiness or misery* of his fellow-creatures. He has made him sensible of their good and happiness, but especially of their ill and misery, by an immediate sympathy, or quick feeling of *pleasure and of pain*.

The latter we call *PITY or COMPASSION*. For the former, though every one, who is not quite divested of humanity, feels it in some degree, we have not got a name, unless we call it *CONGRATULATION or JOYFUL SYMPATHY*, or that *good humour* which arises on seeing others pleased or happy. Both these feelings have been called in general the *PUBLIC or COMMON SENSE*, which we feel for others, and are interested in their concerns as really, though perhaps less sensibly than in our own.

When we see our fellow-creatures unhappy through the fault or injury of others, we feel *repentment or indignation* against the *unjust* causers of that misery. If we are conscious that it has happened through our fault or *injurious* conduct, we feel *shame*; and both these classes of *senses and passions*, regarding *misery and wrong*, are armed with such sharp sensations of *pain* as not only prove a powerful guard and security to the *species, or public system*, against those ills it may, but serve also to lessen or remove those ills it does, suffer. Compassion draws us out of ourselves to bear a part of the misfortunes of others, powerfully sollicit us in their favour, melts us at sight of their distresses,

55  
Man's outward state.

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stres, and makes us in some degree unhappy till they are relieved from it. It is peculiarly well adapted to the condition of human life, because it is much more often in our power to do mischief than good, and to prevent or lessen misery than to communicate positive happiness; and therefore it is an admirable restraint upon the more selfish passions, or those violent impulses that carry us to the hurt of others.

There are other particular *instincts* or *passions* which interest us in the concerns of others, even while we are most busy about our own, and which are strongly attractive of good, and repulsive of ill to them. Such are *natural affection, friendship, love, gratitude, desire of fame, love of society, of one's country*, and others that might be named. Now as the *private* appetites and passions were found to be armed with strong sensations of desire and uneasiness, to prompt man the more effectually to sustain labours, and to encounter dangers in pursuit of those goods that are necessary to the preservation and welfare of the individual, and to avoid those ills which tend to his destruction; in like manner it was necessary, that this *other* class of desires and affections should be prompted with as quick sensations of pain, not only to counteract the strength of their antagonists, but to engage us in a virtuous activity for our relations, families, friends, neighbours, country. Indeed our *sense of right and wrong* will admonish us that it is our *duty*, and *reason and experience* farther assure us that it is both our *interest* and best *security*, to promote the happiness of others; but that *sense*, that *reason*, and that *experience*, would frequently prove but weak and ineffectual prompters to such a conduct, especially in cases of danger and hardship; and amidst all the importunities of nature, and that constant hurry in which the *private* passions involve us, without the aid of those particular *kind* affections which mark out to us particular spheres of duty, and with an agreeable violence engage and fix us down to them.

It is evident, therefore, that those two classes of affection, the *private* and *public*, are set one against the other, and designed to control and limit each other's influence, and thereby to produce a just balance in the whole\*. In general, the violent sensations of pain and uneasiness which accompany hunger, thirst, and the other private appetites, or too great fatigue of mind as well as of body, prevent the individual from running to great excesses in the exercise of the higher functions of the mind, as too intense thought in the search of truth, violent application to business of any kind, and different degrees of romantic heroism. On the other hand, the finer senses of *perception*, and those *generous desires and affections* which are connected with them, the *love of action, of imitation, of truth, honour, public virtue*, and the like, are wisely placed in the opposite scale, in order to prevent us from sinking into the dregs of the *animal* life, and debasing the dignity of man below the condition of brutes. So that, by the mutual re-action of those opposite powers, the bad effects are prevented that would naturally result from their acting singly and apart, and the good effects are produced which each are severally formed to produce.

The same wholesome opposition appears likewise

in the particular counter-workings of the *private* and *public* affections one against the other. Thus *compassion* is adapted to counterpoise the *love of ease, of pleasure, and of life*, and to disarm or to set bounds to *resentment*; and *resentment* of injury done to ourselves, or to our friends who are dearer than ourselves, prevents an effeminate *compassion* or *conservation*, and gives us a noble contempt of labour, pain, and death. *Natural affection, friendship, love of one's country*, nay, *zeal* for any particular virtue, are frequently more than a match for the whole train of *selfish* passions. On the other hand, without that intimate over-ruling passion of *self-love*, and those private desires which are connected with it, the *social and tender instincts* of the human heart would degenerate into the wildest dotage, the most torturing anxiety, and downright frenzy.

But not only are the different orders or classes of affection checks one upon another, but passions of the same classes are mutual clogs. Thus, how many are withheld from the violent outrages of *resentment* by *fear*? And how easily is *fear* controlled in its turn, while mighty wrongs awaken a mighty *resentment*? The *private* passions often interfere, and therefore moderate the violence of each other; and a calm *self-love* is placed at their head, to direct, influence, and control their particular attractions and repulsions. The *public* affections likewise restrain one the other; and all of them are put under the control of a calm dispassionate *benevolence*, which ought in like manner to direct and limit their particular motions. Thus most part, if not all the passions, have a twofold aspect, and serve a twofold end. In *one* view they may be considered as *powers*, impelling mankind to a certain course, with a force proportioned to the *apprehended moment* of the good they aim at. In *another* view they appear as *weights*, balancing the action of the *powers*, and controlling the violence of their impulses. By means of these *powers* and *weights* a natural *poise* is settled in the human breast by its all-wise Author, by which the creature is kept tolerably steady and regular in his course, amidst that variety of stages through which he must pass.

But this is not all the provision which God has made for the hurry and perplexity of the scene in which man is destined to act. Amidst those infinite attractions and repulsions towards private and public good and ill, mankind either cannot often foresee the *consequences or tendencies* of all their actions towards one or other of these, especially where those tendencies are intricate and point different ways, or those consequences remote and complicated; or though, by careful and cool inquiry, and a due improvement of their rational powers, they might find them out, yet, distracted as they are with business, amused with trifles, dissipated by pleasure, and disturbed by passion, they either have or can find no leisure to attend to those consequences, or to examine how far this or that conduct is productive of private or public good on the whole. Therefore, were it left entirely to the flow and sober deductions of reason to trace those tendencies, and make out those consequences, it is evident, that in many particular instances the business of life must stand still, and many important occasions of action

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Contrast of  
balance of  
public and  
private pas-  
sions.

64  
Contrasts a-  
mong those  
of the same  
classes.

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Particular  
perceptions  
or instincts  
of approba-  
tion.

61  
Public af-  
fections.

62  
Contrast of  
balance of  
passions.

\* Vid. Hut-  
cheson's  
Conduct of  
the Passions,  
sect. 1. § 2.

tion be lost, or perhaps the grossest blunders be committed. On this account the Deity, besides that general approbation which we bestow on every degree of kind affection, has moreover implanted in man many particular *perceptions* or *determinations* to approve of certain *qualities* or *actions*, which, in effect, tend to the advantage of society, and are connected with private good, though he does not always see that tendency, nor mind that connection. And these *perceptions* or *determinations* do without reasoning point out, and antecedent to views of interest, prompt to a conduct beneficial to the *public*, and useful to the *private* system. Such is that *sense* of candour and veracity, that abhorrence of fraud and falsehood, that *sense* of fidelity, justice, gratitude, greatness of mind, fortitude, clemency, decorum; and that disapprobation of knavery, injustice, ingratitude, meanness of spirit, cowardice, cruelty, and indecorum, which are natural to the human mind. The former of those dispositions, and the actions flowing from them, are approved, and those of the latter kind disapproved by us, even abstracted from the view of their tendency or conduciveness to the happiness or misery of others, or of ourselves. In one we discern a *beauty*, a *superior excellency*, a congruity to the *dignity* of man; in the other a *deformity*, a *littleness*, a *debasement*, of human nature.

66

Others of an inferior order.

There are other principles also connected with the good of society, or the happiness and perfection of the individual, though that connection is not immediately apparent which we behold with real complacency and approbation, though perhaps inferior in degree, if not in kind, such as *gravity*, *modesty*, *simplicity* of deportment, *temperance*, *prudent economy*; and we feel some degree of contempt and dislike where they are wanting, or where the opposite qualities prevail. These and the like *perceptions* or *feelings* are either different *modifications* of the *moral sense*, or *subordinate* to it, and plainly serve the same important purpose, being expeditious *monitors* in the several emergencies of a various and distracted life, of what is *right*, what is *wrong*, what is to be *pursued*, and what *avoided*; and, by the pleasant or painful consciousness which attends them, exerting their influence as powerful *prompters* to a suitable conduct.

67

Their general tendencies.

From a slight inspection of the above-named principles, it is evident they all carry a friendly aspect to *society* and the *individual*, and have a more immediate or a more remote tendency to promote the *perfection* or *good* of both. This tendency cannot be always foreseen, and would be often mistaken or seldom attended to by a weak, busy, short-sighted creature like man, both rash and variable in his opinions, a dupe to his own passions, or to the designs of others, liable to sickness, to want, and to error. Principles, therefore, which are so nearly linked with *private security* and *public good*, by directing him, without operose reasoning, where to find one and how to promote the *other*; and, by prompting him to a conduct conducive to both, are admirably adapted to the exigencies of his present state, and wisely calculated to obtain the ends of universal benevolence.

It were easy, by considering the subject in another light, to shew, in a curious detail of particulars, how

wonderfully the inside of man, or that astonishing train of *moral powers* and *affections* with which he is endued, is fitted to the several stages of that *progressive* and *probationary* state through which he is destined to pass. As our faculties are narrow and limited, and rise from very small and imperfect beginnings, they must be improved by exercise, by attention, and repeated trials. And this holds true not only of our *intellectual*, but of our *moral* and *active* powers. The former are liable to errors in speculation, the latter to blunders in practice, and both often terminate in misfortunes and pains. And those errors and blunders are generally owing to our passions, or to our too forward and warm admiration of those partial goods they naturally pursue, or to our fear of those partial ills they naturally repel. Those misfortunes, therefore, lead us back to consider where our misconduct lay, and whence our errors flowed; and consequently are salutary pieces of trial, which tend to enlarge our views, to *correct* and *refine* our passions, and consequently improve both our *intellectual* and *moral* powers. Our passions then are the rude materials of our virtue, which Heaven has given us to work up, to refine and polish into an harmonious and divine piece of workmanship. They furnish out the whole machinery, the calms and storms, the lights and shades of human life. They shew mankind in every attitude and variety of character, and give *virtue* both its struggles and its triumphs. To conduct them well in every state, is merit; to abuse or misapply them, is demerit.

69

To a progressive state.

The different sets of *senses*, *powers*, and *passions*, which unfold themselves in those successive stages, are both necessary and adapted to that *rising* and *progressive* state. Enlarging views and growing connections require new passions and new habits; and thus the mind, by these continually expanding and finding a progressive exercise, rises to higher improvements, and pushes forward to maturity and perfection.

70, [71] Harmony of our structure and state.

In this beautiful economy and harmony of our structure, both outward and inward, with that state we may at once discern the great lines of our duty traced out in the fairest and brightest characters, and contemplate with admiration a more august and marvellous scene of divine wisdom and goodness laid in the human breast, than we shall perhaps find in the whole compass of nature.

72

In what economy virtue consists.

From this detail it appears, that man, by his original frame, is made for a *temperate*, *compassionate*, *benevolent*, *active*, and *progressive* state. He is strongly attractive of the *good*, and repulsive of the *ill*, which befall others as well as himself. He feels the highest approbation and moral complacency in those affections, and in those actions, which immediately and directly respect the *good* of others, and the highest disapprobation and abhorrence of the contrary. Besides these, he has many particular *perceptions* or *instincts* of approbation, which, though perhaps not of the same kind with the others, yet are accompanied with correspondent degrees of affection, proportioned to their respective tendencies to the *public good*. Therefore, by acting agreeably to these principles, man acts agreeably to his structure, and fulfils the benevolent

nevolent intentions of its author. But we call a thing *good* when it answers its *end*, and a creature *good* when he acts in a *conformity* to his *constitution*. Con-

sequently, *man* must be denominated *good* or *virtuous* when he acts suitably to the *principles* and *destination* of his nature.

## P A R T II.

## C H A P. I.

## The principal Distinctions of DUTY or VIRTUE.

WE have now considered the *constitution* and *conformations* of *man*, and on those erected a general system of *duty* or *moral obligation*, consonant to *reason*, approved by his most sacred and intimate *sense*, suitable to his *mixed condition*, and confirmed by the *experience* of mankind. We have also traced the *final causes* of his *moral faculties* and *affections* to those noble purposes they answer, with regard both to the *private* and the *public system*.

From this induction it is evident, that there is one order or class of duties which *man* owes to *himself*: another to *society*: and a third to *God*.

The duties he owes to *himself* are founded chiefly on the *defensive* and *private* passions, which prompt him to pursue whatever tends to *private good* or *happiness*, and to avoid or ward off whatever tends to *private ill* or *misery*. Among the various goods which allure and solicit him, and the various ills which attack or threaten him, "To be intelligent and accurate in selecting *one*, and rejecting the *other*, or in preferring the most *excellent goods*, and avoiding the most *terrible ills*, when there is a competition among either, and to be discreet in using the best means to attend the *goods* and avoid the *ills*, is what we call *prudence*." This, in our *inward* frame, corresponds to *sagacity*, or *quickness of sense* in our *outward*.—"To proportion our *defensive passions* to our *dangers*, we call *fortitude*;" which always implies "a just mixture of calm resentment or animosity, and a well-governed caution." And this *firmness of mind* answers to the *strength* and *muscling* of the *body*.—And "duly to adjust our *private passions* to our wants, "or to the respective moment of the good we affect "or pursue, we call *temperance*;" which does therefore always imply, in this large sense of the word, "a just balance or command of the passions."

The *second class* of duties arises from the *public* or *social affections*, "the just harmony or proportion of which to the *dangers* and *wants* of others, and to the *several relations* we bear, commonly goes by the name of *justice*." This includes the whole of our duty to *society*, to its *parent*, and the *general polity* of *nature*; particularly *gratitude*, *friendship*, *sincerity*, *natural affection*, *benevolence*, and the other *social virtues*: This, being the *noblest temper*, and *fairest complexion* of the soul, corresponds to the *beauty* and *fine proportion* of the person. The virtues comprehended under the former class, especially *prudence* and *fortitude*, may likewise be transferred to this; and according to the various circumstances in which they are placed, and the more confined or more extensive sphere in which they operate, may be denominated *private*, *economical*, or *civil prudence*, *fortitude*, &c. These direct our conduct with regard to

the *wants* and *dangers* of those lesser or greater circles with which they are connected.

The *third class* of duties respects the *DEITY*, and arises from the *public affections*, and the several *glorious relations* which he sustains to us, as our *creator*, *benefactor*, *lawgiver*, *judge*, &c.

We chose to consider this *set* of duties in the last place, because, though *prior* in dignity and excellency, they seem to be *last* in order of time, as thinking it the most simple and easy method to follow the gradual progress of nature, as it takes its rise from individuals, and spreads through the *social system*, and still ascends upwards, till at length it stretches to its almighty Parent and Head, and so terminates in those duties which are *highest* and *best*.

The duties resulting from these *relations* are, *reverence*, *gratitude*, *love*, *resignation*, *dependence*, *obedience*, *worship*, *praise*; which, according to the model of our finite capacities, must maintain some sort of proportion to the grandeur and perfection of the object whom we venerate, love, and obey. "This *proportion* or *harmony* is expressed by the general name of *piety* or *devotion*," which is always stronger or weaker according to the greater or less apprehended excellency of its object. This sublime principle of virtue is the enlivening soul which animates the *moral system*, and that cement which binds and sustains the other duties which *man* owes to *himself* or to *society*.

This then is the general temper and constitution of virtue, and these are the principal lines or divisions of duty. To those good dispositions which respect the several objects of our duty, and to all actions which flow from such dispositions, the mind gives its sanction or testimony. And this sanction or judgment concerning the moral quality, or the goodness of actions or dispositions, moralists call *conscience*. When it judges of an action that is to be performed, it is called an *antecedent conscience*; and when it passes sentence on an action which is performed, it is called a *subsequent conscience*. The tendency of an action to produce happiness, or its external conformity to a law, is termed its *material goodness*. But the good dispositions from which an action proceeds, or its conformity to law in every respect, constitutes its *formal goodness*.

When the mind is ignorant or uncertain about the moment of an action, or its tendency to private or public good, or when there are several circumstances in the case, some of which, being doubtful, render the mind dubious concerning the morality of the action, this is called a *doubtful* or *scrupulous conscience*; if it mistakes concerning these, it is called an *erroneous conscience*. If the *error* or *ignorance* is *involuntary* or *invincible*, the action proceeding from that *error*, or from that *ignorance*, is reckoned *innocent*, or not imputable. If the error or ignorance is *supine* or *affected*, i. e. the effect of negligence, or of affectation

76  
Duties to  
God.77  
Method.78  
Piety.79 [84]  
Conscience,  
and its di-  
visions.85  
Divisions of  
conscience.73  
General di-  
vision of  
duty.74  
Duty to  
one's self.75  
Duties to  
society.

and wilful inadvertence, the conduct flowing from such error, or such ignorance, is *criminal and imputable*. Not to follow one's conscience, though erroneous and ill-informed, is *criminal*, as it is the guide of life; and to counteract it, shews a depraved and incorrigible spirit. Yet to follow an erroneous conscience is likewise criminal, if that error which misled the conscience was the effect of inattention, or of any criminal passion\*.

\* Hatchef.  
Mor. Inst.  
lib. 2 c. 3.  
86

How con-  
science is to  
be rectified.

If it be asked, "How an erroneous conscience shall be rectified, since it is supposed to be the only guide of life, and judge of morals?" We answer, in the very same way that we would rectify reason if at any time it should judge wrong, as it often does, *viz.* by giving it proper and sufficient materials for judging right, *i. e.* by inquiring into the whole state of the case, the relations, connections, and several obligations of the actor, the consequences and other circumstances of the action, or the purpose of private or public good which results, or is likely to result, from the action or from the omission of it. If those circumstances are fairly and fully stated, the conscience will be just and impartial in its decision: for, by a necessary law of our nature, it approves and is well affected to the *moral form*; and if it seems to approve of *vice or immorality*, it is always under the notion or mask of some *virtue*. So that, strictly speaking, it is not conscience which errs; for its sentence is always conformable to the view of the case which lies before it; and is *just*, upon the supposition that the case is truly such as it is represented to it. All the fault is to be imputed to the agent, who neglects to be better informed, or who, through weakness or wickedness, hastens to pass sentence from an imperfect evidence.

## CHAP. II.

### Of Man's Duty to HIMSELF. Of the Nature of GOOD, and the Chief GOOD.

87  
Divisions  
of good.

EVERY creature, by the constitution of his nature, is determined to love himself; to pursue whatever tends to his preservation and happiness, and to avoid whatever tends to his hurt and misery. Being endowed with sense and perception, he must necessarily receive *pleasure* from some objects, and *pain* from others. Those objects which give pleasure, are called *good*; and those which give pain, *evil*. To the former he feels that attraction or motion we call *desire*, or *love*: To the latter, that impulse we call *aversion*, or *hatred*. To objects which suggest neither pleasure nor pain, and are apprehended of no use to procure one or ward off the other, we feel neither *desire nor aversion*; and such objects are called *indifferent*. Those objects which do not of themselves produce pleasure or pain, but are the *means* of procuring either, we call *useful or noxious*. Towards them we are affected in a subordinate manner, or with an *indirect and reflective* rather than a *direct and immediate* affection. All the original and particular affections of our nature lead us out to and ultimately rest in the first kind of objects, *viz.* those which give immediate pleasure, and which we therefore call *good, directly so*. The calm affection of *self-love* alone is conversant about such objects

as are only *consequentially good*, or merely useful to ourselves.

But, besides those sorts of objects which we call *good*, merely and solely as they give pleasure, or are means of procuring it, there is an higher and nobler species of good, towards which we feel that peculiar movement we call *approbation or moral complacency*; and which we therefore denominate *moral good*. Such are our affections, and the consequent actions to them. The perception of this is, as has been already observed, quite distinct in kind from the perception of other species; and though it may be connected with *pleasure or advantage* by the benevolent constitution of nature, yet it constitutes a *good* independent of that pleasure and that advantage, and far superior not in degree only but in dignity to both. The *other, viz.* the *natural good*, consists in obtaining those pleasures which are adapted to the peculiar senses and passions susceptible of them, and is as various as are those senses and passions. This, *viz.* the *moral good*, lies in the right conduct of the several senses and passions, or their just proportion and accommodation to their respective objects and relations; and this is of a more simple and invariable kind.

88  
Moral  
good.

By our several senses we are capable of a great variety of pleasing sensations. These constitute distinct ends, or objects ultimately pursuable for their own sake. To these ends, or ultimate objects, correspond peculiar appetites or affections, which prompt the mind to pursue them. When these ends are attained, there it rests, and looks no farther. Whatever therefore is pursuable, not on its own account, but as subservient or necessary to the attainment of something else that is intrinsically valuable for its own sake, be that value ever so great, or ever so small, we call a *mean*, and not an *end*. So that *ends and means* constitute the *materials*, or the very *essence* of our *happiness*. Consequently happiness, *i. e.* human happiness, cannot be one simple uniform thing in creatures constituted, as we are, with such various senses of pleasure, or such different capacities of enjoyment. Now the same principle, or law of our nature, which determines us to pursue any one end or species of good, prompts us to pursue every other end or species of good of which we are susceptible, or to which our Maker has adapted an original propension. But, amidst the great multiplicity of *ends or goods* which form the various ingredients of our happiness, we perceive an evident *gradation or subordination* suited to that gradation of *senses, powers, and passions*, which prevails in our mixed and various constitution, and to that ascending series of connections which open upon us in the different stages of our progressive fate.

89  
Human  
happiness.

Thus the goods of the *body*, or of the *external senses*, seem to hold the lowest rank in this gradation or scale of goods. These we have in common with the brutes; and though many men are brutish enough to pursue the goods of the body with a more than brutal fury, yet, when at any time they come in competition with goods of an higher order, the unanimous verdict of mankind, by giving the last the preference, condemns the first to the meanest place. Goods consisting in exterior social connections, as  *fame, fortune, power,*

90  
Gradation  
of goods.

*civil*

*civil authority*, seem to succeed next, and are chiefly valuable as the means of procuring *natural or moral good*, but principally the latter. Goods of the intellect are still superior, as *taste, knowledge, memory, judgment*, &c. The highest are moral goods of the mind, directly and ultimately regarding ourselves, as *command of the appetites and passions, prudence, fortitude, benevolence*, &c. These are the great objects of our pursuit, and the principal ingredients of our happiness. Let us consider each of them as they rise one above the other in this natural series or scale, and touch briefly on our obligations to pursue them.

91  
Goods of  
the body.  
92  
Good  
health.

Those of the body are *health, strength, agility, hardiness, and patience of change, neatness, and decency*. Good health, and a regular easy flow of spirits, are in themselves sweet natural enjoyments, a great fund of pleasure, and indeed the proper seasoning which gives a flavour and poignancy to every other pleasure. The want of health unfit us for most duties of life, and is especially an enemy to the social and human affections, as it generally renders the unhappy sufferer peevish and sullen, disgusted at the allotments of providence, and consequently apt to entertain suspicious and gloomy sentiments of its Author. It obstructs the free exercise and full improvement of our reason, makes us a burden to our friends, and useless to society. Whereas the uninterrupted enjoyment of good health is a constant source of good humour, and good humour is a great friend to openness and benignity of heart, enables us to encounter the various ills and disappointments of life with more courage, or to sustain them with more patience; and, in short, conduces much, if we are otherwise duly qualified, to our acting our part in every exigency of life with more firmness, consistency, and dignity. Therefore it imports us much to preserve and improve an habit or enjoyment, without which every other external entertainment is tasteless, and most other advantages of little avail.

93  
How pre-  
served.

And this is best done by a strict temperance in diet and regimen, by regular exercise, and by keeping the mind serene and untroubled by violent passions, and unsubdued by intense and constant labours, which greatly impair and gradually destroy the strongest constitutions.

94  
Strength, a-  
bility, &c.

*Strength, agility, hardiness, and patience of change*, suppose health, and are unattainable without it; but they imply something more, and are necessary to guard it, to give us the perfect use of life and limbs, and to secure us against many otherwise unavoidable ills. The exercise of the necessary manual, and of most of the elegant arts of life, depends on strength and agility of body; personal dangers, private and public dangers, the demands of our friends, our families, and country, require them; they are necessary in war, and ornamental in peace; fit for the employment of a country and a town life, and they exalt the entertainments and diversions of both. They are chiefly obtained by moderate and regular exercise.

95  
How attain-  
ed.

96  
Attitude of  
the angle.

Few are so much raised above want and dependence, or so exempted from business and care, as not to be often exposed to inequalities and changes of diet, exercise, air, climate, and other irregularities. Now, what can be so effectual to secure one against the mischiefs arising from such unavoidable alterations, as har-

diness, and a certain versatility of constitution which can bear extraordinary labours, and submit to great changes, without any sensible uneasiness or bad consequences. This is best attained, not by an over-great delicacy and minute attention to forms, or by an invariable regularity in diet, hours, and way of living, but rather by a bold and discreet latitude of regimen. Besides, deviations from established rules and forms of living, if kept within the bounds of sobriety and reason, are friendly to thought and original sentiments, animate the dull scene of ordinary life and business, and agreeably stir the passions, which stagnate or breed ill-humour in the calms of life.

97  
How attain-  
ed.

*Neatness, cleanliness, and decency*, to which we may add *dignity of countenance, and demeanour*, seem to have something refined and moral in them: at least we generally esteem them indications of an orderly, genteel, and well-governed mind, conscious of an inward worth, or the respect due to one's nature.

98  
Neatness,  
decency,  
&c.

Whereas *nauseousness, slovenliness, awkwardness, and indecency*, are shrewd symptoms of something mean, careless, and deficient, and betray a mind outaught, illiberal, unconscious of what is due to one's self or to others. How much cleanliness conduces to health, needs hardly to be mentioned; and how necessary it is to maintain one's character and rank in life, and to render us agreeable to others as well as to ourselves, is as evident.—There are certain motions, airs, and gestures, which become the human countenance and form, in which we perceive a *comeliness, openness, simplicity, gracefulness*; and there are others, which to our sense of decorum appear *uncomely, affected, dissingenuous, and awkward*, quite unsuitable to the native dignity of our face and form. The first are in themselves the most easy, natural, and commodious, give one boldness and presence of mind, a modest assurance, an address both awful and alluring; they bespeak candour and greatness of mind, raise the most agreeable prejudices in one's favour, render society engaging, command respect, and often love, and give weight and authority both in conversation and business; in fine, they are the colouring of virtue, which shew it to the greatest advantage in whomsoever it is; and not only imitate, but in some measure supply it where it is wanting. Whereas the last, *viz rudeness, affectation, indecorum*, and the like, have all the contrary effects; they are burdensome to one's self, a dishonour to our nature, and a nuisance to society. The former qualities or goods are best attained by a liberal education, by preserving a just sense of the dignity of our nature, by keeping the best and polite company, but, above all, by acquiring those virtuous and ennobling habits of mind which are decency in perfection, which will give an air of unaffected grandeur, and spread a lustre truly engaging over the whole form and deportment.

99  
How attain-  
ed.

We are next to consider these goods which consist in exterior social connections, as *fame, fortune, civil authority, power*.

100  
Goods of  
exterior so-  
cial connec-  
tions.

The first has a two-fold aspect, as a good pleasant in itself, or gratifying to an original passion, and then as expedient or useful towards a farther end. Honour from the wife and good, on the account of a virtuous conduct, is regalating to a good man; for then his heart

101  
Fame.

re-echoes to the grateful found. There are few quite indifferent even to the commendation of the vulgar. Though we cannot approve that conduct which proceeds entirely from this principle, and not from good affection or love of the conduct itself, yet, as it is often a guard and additional motive to virtue in creatures imperfect as we are, and often distracted by interfering passions, it might be dangerous to suppress it altogether, however wise it may be to refrain it within due bounds, and however laudable to use it only as a scaffolding to our virtue, which may be taken down when that glorious structure is finished, but hardly till then. To pursue fame for itself, is innocent; to regard it only as an auxiliary to virtue, is noble; to seek it chiefly as an engine of public usefulness, is still more noble, and highly praise-worthy. For though the opinion and breath of men are transient and fading things, often obtained without merit, and lost without care; yet as our business is with men, and as our capacity of serving them is generally increased in proportion to their esteem of us, therefore found and well-established moral applause may, and will be modestly, not ostentatiously, sought after by the good; not indeed as a solitary refined sort of luxury, but as a public and proper instrument to serve and bless mankind. At the same time they will learn to despise that reputation which is founded on rank, fortune, and any other circumstances or accomplishments that are foreign to real merit, or to useful services done to others, and think that praise of little avail which is purchased without desert, and bestowed without judgment.

102  
Fortune,  
Power, &c.

Fortune, power, and civil authority, or whatever is called influence and weight among mankind, are goods of the second division, that is, valuable and pursuable only as they are *useful*, or as means to a farther end, *viz.* procuring or preserving the immediate objects of enjoyment or happiness to ourselves or others. Therefore to love such goods on their own account, and to pursue them as ends, not the means of enjoyment, must be highly preposterous and absurd. There can be no measure, no limit, to such pursuit; all must be whim, caprice, extravagance. Accordingly such appetites, unlike all the natural ones, are increased by possession, and whetted by enjoyment. They are always precarious, and never without fears, because the objects lie without one's self; they are seldom without sorrow and vexation, because no accession of wealth or power can satisfy them. But if those goods are considered only as the materials or means of private or public happiness, then the same obligations which bind us to pursue the latter, bind us likewise to pursue the former. We may, and no doubt we ought, to seek such a measure of wealth as is necessary to supply all our real wants, to raise us above servile dependence, and provide us with such conveniences as are suited to our rank and condition in life. To be regardless of this measure of wealth, is to expose ourselves to all the temptations of poverty and corruption; to forfeit our natural independency and freedom; to degrade, and consequently to render the rank we hold, and the character we sustain in society, useless, if not contemptible. When these important ends are secured, we ought not to murmur or repine that we possess no more; yet we are not secluded by any obligation, moral or divine, from seek-

103  
How far  
pursuable.

ing more, in order to give us that happiest and most god-like of all powers, the power of *doing good*. A supine indolence in this respect is both absurd and criminal; *absurd*, as it robs us of an inexhausted fund of the most refined and durable enjoyments; and *criminal*, as it renders us so far useless to the society to which we belong. "That pursuit of wealth which goes beyond the former end, *viz.* the obtaining the necessaries, or such conveniences of life, as, in the estimation of reason, not of vanity or passion, are suited to our rank and condition, and yet is not directed to the latter, *viz.* the doing good is what we call *avarice*." And "that pursuit of power, which, after securing one's self, *i. e.* having attained the proper independence and liberty of a rational social creature, is not directed to the good of others, is what we call *ambition*, or the *lust of power*." To what extent the strict measures of virtue will allow us to pursue either wealth or power, and civil authority, is not perhaps possible precisely to determine. That must be left to prudence, and the peculiar character, condition, and other circumstances of each man. Only thus far a limit may be set, that the pursuit of either must enroach upon no other duty or obligation which we owe to ourselves, to society, or to its parent and head. The same reasoning is to be applied to power as to wealth. It is only valuable as an instrument of our own security, and of the free enjoyment of those original goods it may, and often does, administer to us, and, as an engine of more extensive happiness to our friends, our country, and mankind.

104  
Avarice.

105  
Ambition.

Now the best, and indeed the only way to obtain a solid and lasting fame, is an uniform inflexible course of virtue, the employing one's ability and wealth in supplying the wants, and using one's power in promoting or securing the happiness, the rights and liberties of mankind, joined to an universal affability and politeness of manners. And surely one will not mistake the matter much, who thinks the same course conducive to the acquiring greater accessions both of wealth and power; especially if he adds to those qualifications a vigorous industry, a constant attention to the characters and wants of men, to the conjunctures of times, and continually-varying genius of affairs; and a steady intrepid honesty, that will neither yield to the allurements, nor be over-awed with the terrors, of that corrupt and corrupting scene in which we live. We have sometimes heard indeed of other ways and means, as fraud, dissimulation, servility, and prostitution, and the like ignoble arts, by which the men of the world (as they are called, shrewd politicians, and men of address!) amass wealth, and procure power: but as we want rather to form a man of virtue, an honest, contented, happy man, we leave to the men of the world their own ways, and permit them, unenvied and unimitated by us, to reap the fruit of their doings.

106  
How fame  
and power  
are attain-  
ed.

The next species of objects in the scale of good, are the goods of the *intellect*, as *knowledge, memory, judgment, taste, sagacity, docility*, and whatever else we call *intellectual* virtues. Let us consider them a little, and the means as well as obligations to improve them.

107  
Good of the  
intellect.

As man is a rational creature, capable of knowing the differences of things and actions;—as he not only

108  
Their mo-  
ment.  
fees



foes and feels what is present, but remembers what is past, and often foresees what is future;—as he advances from small beginnings, by slow degrees, and with much labour and difficulty, to knowledge and experience:—as his opinions sway his passions,—as his passions influence his conduct,—and as his conduct draws consequences after it, which extend not only to the present, but to the future time, and therefore is the principal source of his happiness or misery; it is evident, that he is formed for intellectual improvements, and that it must be of the utmost consequence for him to improve and cultivate his intellectual powers, on which those opinions, those passions, and that conduct depend\*.

But, besides the future consequences and moment of improving our *intellectual* powers, their immediate exercise on their proper objects yields the most rational and refined pleasures. Knowledge, and a right taste in the arts of *imitation and design*, as *poetry, painting, sculpture, music, architecture*, afford not only an innocent, but a most sensible and sublime entertainment. By these the understanding is instructed in ancient and modern life, the history of men and things, the energies and effects of the passions, the consequences of virtue and vice; by these the imagination is at once entertained and nourished with the beauties of nature and art, lighted up and spread out with the novelty, grandeur, and harmony of the universe; and, in fine, the passions are agreeably roused, and suitably engaged, by the greatest and most interesting objects that can fill the human mind. He who has a taste formed to these ingenious delights, and plenty of materials to gratify it, can never want the most agreeable exercise and entertainment, nor once have reason to make that fashionable complaint of the tediousness of time. Nor can he want a proper subject for the discipline and improvement of his heart. For, being daily conversant with *beauty, order, and design*, in inferior subjects, he bids fair for growing in due time an admirer of what is fair and well-proportioned in the conduct of life and the order of society, which is only *order and design* exerted in their highest subject. He will learn to transfer the numbers of poetry to the harmony of the mind and of well-governed passions; and, from admiring the virtues of others in moral paintings, come to approve and imitate them himself. Therefore to cultivate a *true and correct taste*, must be both our *interest* and our *duty*, when the circumstances of our station give leisure and opportunity for it, and when the doing it is not inconsistent with our higher obligations or engagements to society and mankind.

111  
How attained.

It is best attained by reading the best books, where *good sense* has more the ascendant than *learning*, and which pertain more to *practice* than to *speculation*; by studying the best models, *i. e.* those which profess to imitate nature most, and approach the nearest to it, and by conversing with men of the most refined taste, and the greatest experience in life.

112  
Moment of intellectual goods.

As to the other intellectual goods, what a fund of entertainment must it be to investigate the truth and various relations of things, to trace the operations of nature to general laws, to explain by these its manifold phenomena, to understand that order by which the universe is upheld, and that œconomy by which it

is governed; to be acquainted with the human mind, the connections, subordinations, and uses of its powers, and to mark their energy in life! how agreeable to the ingenious inquirer, to observe the manifold relations and combinations of individual minds in society, to discern the causes why they flourish or decay; and from thence to ascend, through the vast scale of beings, to that general mind which presides over all, and operates unseen in every system and in every age, through the whole compass and progression of nature! devoted to such entertainments as these, the contemplative have abandoned every other pleasure, retired from the body, so to speak, and sequestered themselves from social intercourse; for these, the *busy* have often preferred to the hurry and din of life the calm retreats of contemplation; for these, when once they came to taste them, even the *gay and voluptuous* have thrown up the lawless pursuits of sense and appetite, and acknowledged these mental enjoyments to be the most *re.fined*, and indeed the *only* luxury. Besides, by a just and large knowledge of nature, we recognize the perfections of its author; and thus piety, and all those pious affections which depend on just sentiments of his character, are awakened and confirmed; and a thousand superfluous fears, that arise from partial views of his nature and works, will of course be excluded. An extensive prospect of human life, and of the periods and revolutions of human things, will conduce much to the giving a certain greatness of mind, and a noble contempt to those little competitions about power, honour, and wealth, which disturb and divide the bulk of mankind; and promote a calm endurance of those inconveniences and ills that are the common appendages of humanity. Add to all, that a just knowledge of human nature, and of those hinges upon which the business and fortunes of men turn, will prevent our thinking either too highly or too meanly of our fellow-creatures, give no small scope to the exercise of friendship, confidence, and good-will, and at the same time brace the mind with a proper caution and distrust, those nerves of prudence, and give a greater mastery in the conduct of private as well as public life. Therefore, by cultivating our intellectual abilities, we shall best promote and secure our interest, and be qualified for acting our part in society with more honour to ourselves, as well as advantage to mankind. Consequently, to improve them to the utmost of our power is our duty; they are talents committed to us by the almighty Head of society, and we are accountable to him for the use of them.

The intellectual virtues are best improved by accurate and impartial observation, extensive reading, and ed. unconfined converse with men of all characters, especially with those who, to private study, have joined the widest acquaintance with the world, and greatest practice in affairs; but, above all, by being much in the world, and having large dealings with mankind. Such opportunities contribute much to divert one of prejudices and a servile attachment to crude systems, to open one's views, and to give that experience on which the most useful, because the most practical knowledge is built, and from which the surest maxims for the conduct of life are deduced.

114  
How attained  
of goods

The highest goods which enter into the composition Moral

of human happiness are *moral goods* of the mind, directly and ultimately regarding ourselves; as *command of the appetites and passions, prudence and caution, magnanimity, fortitude, humility, love of virtue, love of God, resignation*, and the like. These sublime goods are goods by way of eminence, goods recommended and enforced by the most intimate and awful sense and consciousness of our nature; goods that constitute the quintessence, the very temper of happiness, that form and completion of soul which renders us approvable and lovely in the sight of God; goods, in fine, which are the elements of all our future perfection and felicity.

115  
Their  
ment.

Most of the other goods we have considered depend partly on ourselves, and partly on accidents which we can neither foresee nor prevent, and result from causes which we cannot influence or alter. They are such goods as we may possess to-day and lose to-morrow, and which require a felicity of constitution, and talents to attain them in full vigour and perfection, and a felicity of conjunctures to secure the possession of them. Therefore, did our happiness depend altogether or chiefly on such transitory and precarious possessions, it were itself most precarious, and the highest folly to be anxious about it. — But though creatures, constituted as we are, cannot be indifferent about such goods, and must suffer in some degree, and consequently have our happiness incomplete without them, yet they weigh but little in the scale when compared with moral goods. By the benevolent constitution of our nature these are placed within the sphere of our activity, so that no man can be destitute of them unless he is first wanting to himself. Some of the wisest and best of mankind have wanted most of the former goods, and all the external kind, and felt most of the opposite ills, such at least as arise from without; yet by possessing the latter, *viz.* the moral goods, have declared they were happy; and to the conviction of the most impartial observers have appeared happy. The world of men have been surrounded with every outward good and advantage of fortune, and have possessed great parts; yet, for want of moral rectitude, have been, and have confessed themselves, notoriously and exquisitely miserable. The exercise of virtue has supported its votaries, and made them exult in the midst of tortures almost intolerable; nay, how often has some false form or shadow of it sustained even the greatest \* villains and bigots under the same pressures! But no external goods, no goods of fortune, have been able to alleviate the agonies or expel the fears of a guilty mind, conscious of the deserved hatred and reproach of mankind, and the just displeasure of Almighty God.

116  
The mixed  
condition  
of human  
life requires  
particular  
virtues.

As the present condition of human life is wonderfully chequered with good and ill, and as no height of station, no affluence of fortune, can absolutely insure the good, or secure against the ill, it is evident that a great part of the comfort and serenity of life must lie in having our minds duly affected with regard to both, *i. e.* rightly attempered to the loss of one and the sufferance of the other. For it is certain that outward calamities derive their chief malignity and pressure

from the inward dispositions with which we receive them. By managing these right, we may greatly abate that malignity and pressure, and consequently diminish the number, and weaken the moment, of the ills of life, if we should not have it in our power to obtain a large share of its goods. There are particularly three virtues which go to the forming this right temper towards ill, and which are of singular efficacy, if not totally to remove, yet wonderfully to alleviate, the calamities of life. These are *fortitude, or patience, humility, and resignation*.

117  
Fortitude.

*Fortitude* is that calm and steady habit of mind which either moderates our fears, and enables us bravely to encounter the prospect of ill, or renders the mind serene and invincible under its immediate pressure. It lies equally distant from rashness and cowardice; and though it does not hinder us from feeling, yet prevents our complaining or shrinking under the stroke. It always includes a generous contempt of, or at least a noble superiority to, those precarious goods of which we can insure neither the possession nor continuance. The man therefore who possesses this virtue in this ample sense of it, stands upon an eminence, and sees human things below him; the tempest indeed may reach him, but he stands secure and collected against it upon the basis of conscious virtue, which the severest storms can seldom shake, and never overthrow.

118  
Humility.

*Humility* is another virtue of high rank and dignity, though often mistaken for proud mortals for meanness and pusillanimity. It is opposed to *pride*, which commonly includes in it a false or over-rated estimation of our own merit, an aspersion of it to ourselves as its only and original cause, an undue comparison of ourselves with others, and, in consequence of that supposed superiority, an arrogant preference of ourselves, and a supercilious contempt of them. *Humility*, on the other hand, seems to denote that modest and ingenuous temper of mind, which arises from a just and equal estimate of our own advantages compared with those of others, and from a sense of our deriving all originally from the Author of our being. Its ordinary attendants are mildness, a gentle forbearance, and an easy unassuming humanity with regard to the imperfections and faults of others; virtues rare indeed, but of the fairest complexion, the proper offspring of so lovely a parent, the best ornaments of such imperfect creatures as we are, precious in the sight of God, and which sweetly allure the hearts of men.

119  
Resignation

*Resignation* is that mild and heroic temper of mind which arises from a sense of an infinitely wise and good providence, and enables one to acquiesce with a cordial affection in its just appointments. This virtue has something very peculiar in its nature, and sublime in its efficacy. For it teaches us to bear ill not only with patience, and as being unavoidable, but it transforms, as it were, ill into good, by leading us to consider it, and every event that has the least appearance of ill, as a divine dispensation, a wise and benevolent temperament of things, subservient to universal good, and, of course, including that of every individual, especially of such as calmly stoop to it. In this light,

\* As Ravilliac, who assassinated Henry the fourth of France; and Balthazar Gerard, who murdered William the First, prince of Orange.

the administration itself, nay every act of it, becomes an object of affection, the evil disappears, or is converted into a balm which both heals and nourisheth the mind. For, though the first unexpected access of ill may surprize the soul into grief, yet that grief, when the mind calmly reviews its object, changes into contentment, and is by degrees exalted into veneration and a divine composure. Our private will is lost in that of the Almighty, and our security against every real ill rests on the same bottom as the throne of him who lives and reigns for ever.

120  
Chief good,  
Objective  
and formal.

Before we finish this section, it may be fit to observe, that as the Deity is the supreme and inexhausted source of good, on whom the happiness of the whole creation depends; as he is the highest object in nature, and the only object who is fully proportioned to the intellectual and moral powers of the mind, in whom they ultimately rest, and find their most perfect exercise and completion, he is therefore termed the *Chief good of man, objectively* considered. And *virtue*, or the proportioned and vigorous exercise of the several powers and affections on their respective objects, as above described, is, in the schools, termed the *chief good, formally* considered, or its *formal* idea, being the inward temper and native constitution of human happiness.

From the detail we have gone through, the following corollaries may be deduced.

121  
Corollaries.

1. *First*, It is evident, that the happiness of such a progressive creature as man can never be at a stand, or continue a fixed invariable thing. His finite nature, let it rise ever so high, admits still higher degrees of improvement and perfection. And his progression in improvement or virtue always makes way for a progression in happiness. So that no possible point can be assigned in any period of his existence in which he is perfectly happy, that is, so happy as to exclude higher degrees of happiness. All his perfection is only comparative. 2. It appears that many things must conspire to complete the happiness of so various a creature as man, subject to so many wants, and susceptible of such different pleasures. 3. As his capacities of pleasure cannot be all gratified at the same time, and must often interfere with each other in such a precarious and fleeting state as human life, or be frequently disappointed, perfect happiness, *i. e.* the undisturbed enjoyment of the several pleasures of which we are capable, is unattainable in our present state. 4. That state is most to be sought after, in which the fewest competitions and disappointments can happen, which least of all impairs any sense of pleasure, and opens an inexhausted source of the most refined and lasting enjoyments. 5. That state which is attended with all those advantages, is a state or course of virtue. 6. *Therefore*, a state of *virtus*, in which the moral goods of the mind are attained, is the *happiest* state.

### CHAP. III.

#### Duties to SOCIETY.

##### SECT. I. Filial and Fraternal Duty.

As we have followed the order of nature in tracing the history of man, and those duties which he owes to

himself, it seems reasonable to take the same method with those he owes to society, which constitute the *second class* of his obligations.

His parents are among the earliest objects of his attention; he becomes soonest acquainted with them, reposes a peculiar confidence in them, and seems to regard them with a fond affection, the early prognostics of his future *piety* and *gratitude*. Thus does nature dictate the first lines of filial duty, even before a just sense of the connection is formed. But when the child is grown up, and has attained to such a degree of understanding, as to comprehend the *moral tie*, and be sensible of the obligations he is under to his parents; when he looks back on their tender and disinterested affection, their incessant cares and labours in nursing, educating, and providing for him, during that state in which he had neither prudence nor strength to care and provide for himself, he must be conscious that he owes to them these peculiar duties.

122  
Connection  
of parents.

To reverence and honour them, as the instruments of nature in introducing him to life, and to that state of comfort and happiness which he enjoys; and therefore to esteem and imitate their good qualities, to alleviate and bear with, and spread; as much as possible, a decent veil over their faults and weaknesses.

123  
Duties to  
parents.

2. To be highly grateful to them, for those favours which it can hardly ever be in his power fully to repay; to shew this gratitude by a strict attention to their wants, and a solicitous care to supply them; by a submissive deference to their authority and advice, especially by paying great regard to it in the choice of a wife, and of an occupation; by yielding to, rather than peevishly contending with, their humours, as remembering how oft they have been persecuted by his; and, in fine, by soothing their cares, lightening their sorrows, supporting the infirmities of age, and making the remainder of their life as comfortable and joyful as possible.

124  
Duties to  
brethren  
and sisters.

As his brethren and sisters are the next with whom the creature forms a *social* and *moral* connection, to them he owes a *fraternal* regard; and with them ought he to enter into a strict league of friendship, mutual sympathy, advice, assistance, and a generous intercourse of kind offices, remembering their relation to common parents, and that brotherhood of nature which unites them into a closer community of interest and affection.

##### SECT. II. Concerning Marriage.

WHEN man arrives to a certain age, he becomes sensible of a peculiar sympathy and tenderness towards the other sex; the charms of beauty engage his attention, and call forth new and softer dispositions than he has yet felt. The many amiable qualities exhibited by a fair outside, or by the mild allurement of female manners, or which the prejudiced spectator without much reasoning supposes those to include, with several other circumstances both natural and accidental, point his view and affection to a particular object, and of course contract that general rambling regard, which was lost and useless among the undistinguished crowd, into a peculiar and permanent attachment to one woman, which ordinarily terminates in the most important, venerable, and delightful connection in life.

125  
Connection  
with the  
other sex.

126  
The grounds of this connection.

The state of the brute creation is very different from that of human creatures. The former are clothed and generally armed by their structure, easily find what is necessary to their subsistence, and soon attain their vigour and maturity; so that they need the care and aid of their parents but for a short while; and therefore we see that nature has assigned to them vagrant and transient amours: The connection being purely *natural*, and merely for propagating and rearing their offspring, no sooner is that end answered, than the connection dissolves of course. But the human race are of a more tender and defenceless constitution; their infancy and non-age continue longer; they advance slowly to strength of body, and immaturity of reason; they need constant attention, and a long series of cares and labours, to train them up to decency, virtue, and the various arts of life. Nature has, therefore, provided them with the most affectionate and anxious tutors, to aid their weakness, to supply their wants, and to accomplish them in those necessary arts, even their own parents, on whom she has devolved this mighty charge, rendered agreeable by the most alluring and powerful of all ties, parental affection. But unless both concur in this grateful task, and continue their joint labours, till they have reared up and planted out their young colony, it must become a prey to every rude invader, and the purpose of nature in the original union of the human pair be defeated. Therefore our structure as well as condition is an evident indication, that the human sexes are destined for a more intimate, for a moral and lasting union. It appears likewise, that the principal end of marriage is not to propagate and nurse up an offspring, but to educate and form minds for the great duties and extensive destinations of life. Society must be supplied from this original nursery with useful members, and its fairest ornaments and supports.

127 [128]  
Moral ends of marriage.

The mind is apt to be dissipated in its views and acts of friendship and humanity; unless the former be directed to a particular object, and the latter employed in a particular province. When men once indulge to this dissipation, there is no stopping their career, they grow insensible to moral attractions, and, by obstructing or impairing the decent and regular exercise of the tender and generous feelings of the human heart, they in time become unqualified for, or averse to, the forming a moral union of souls, which is the cement of society, and the source of the purest domestic joys. Whereas a rational, undepraved *love*, and its fair companion, *marriage*, collect a man's views, guide his heart to its proper object, and, by confining his affection to that object, do really enlarge its influence and use. Besides, it is but too evident from the conduct of mankind, that the common ties of humanity are too feeble to engage and interest the passions of the generality in the affairs of society. The connections of neighbourhood, acquaintance, and general intercourse, are too wide a field of action for many, and those of a *public* or *community* are so for more; and in which they either care not, or know not how to exert themselves. Therefore nature, ever wise and benevolent, by implanting that strong sympathy which reigns between the individuals of each sex, and by urging them to form a particular moral connection,

the spring of many domestic endearments, has measured out to each pair a particular *sphere of action*, proportioned to their views, and adapted to their respective capacities. Besides, by intersting them deeply in the concerns of their own little circle, she has connected them more closely with society, which is composed of particular families, and bound them down to their good behaviour in that particular community to which they belong. This *moral connection* is *marriage*, and this *sphere of action* is a *family*.

Of the *conjugal* alliance the following are the *natural laws*. First, mutual fidelity to the marriage-bed. Disloyalty defeats the very end of marriage, dissolves the natural cement of the relation, weakens the moral tie, the chief strength of which lies in the reciprocation of affection; and, by making the offspring uncertain, diminishes the care and attachment necessary to their education.

2. A conspiration of counsels and endeavours to promote the common interest of the family, and to educate their common offspring. In order to observe these laws, it is necessary to cultivate, both before and during the married state, the strictest decency and chastity of manners, and a just sense of what becomes their respective characters.

3. The union must be inviolable, and for life. The nature of friendship, and particularly of this species of it, the education of their offspring, and the order of society and of successions, which would otherwise be extremely perplexed, do all seem to require it. To preserve this union, and render the matrimonial state more harmonious and comfortable, a mutual esteem and tenderness, a mutual defence and forbearance, a communication of advice, and assistance and authority, are absolutely necessary. If either party keep within their proper departments, there need be no disputes about power or superiority, and there will be none. They have no *opposite*, no *separate* interests, and therefore there can be no just ground for opposition of conduct.

From this detail, and the present state of things, in which there is pretty near a parity of numbers of both sexes, it is evident that *polygamy* is an *unnatural* state; and though it should be granted to be more fruitful of children, which however it is not found to be, yet it is by no means so fit for rearing minds, which seems to be as much, if not more, the intention of nature than the propagation of bodies.

### SECT. III. Of Parental Duty.

THE connection of parents with their children is a natural consequence of the matrimonial connection; and the duties which they owe them result as naturally from that connection. The feeble state of children, subject to so many wants and dangers, requires their incessant care and attention; their ignorant and uncultivated minds demand their continual instruction and culture. Had human creatures come into the world with the full strength of *men* and the weakness of *reason* and vehemence of passions which prevail in *children*, they would have been too strong or too stubborn to have submitted to the government and instruction of their parents. But as they were designed for a progression in knowledge and virtue, it was proper that

129

Duties of marriage.

130 [131]  
Polygamy.

132

Connection of parents and children.

that the growth of their bodies should keep pace with that of their minds, left the purposes of that progression should have been defeated. Among other admirable purposes which this gradual expansion of their outward as well as inward structure serves, this is one, that it affords ample scope to the exercise of many tender and generous affections, which fill up the domestic life with a beautiful variety of duties and enjoyments; and are of course a noble discipline for the heart, and an hardy kind of education for the more honourable and important duties of public life.

The above mentioned weak and ignorant state of children, seems plainly to invest their parents with such authority and power as is necessary to their support, protection, and education; but that authority and power can be construed to extend no farther than is necessary to answer those ends, and to last no longer than that weakness and ignorance continue; wherefore, the foundation or reason of the authority and power ceasing, they cease of course. Whatever power or authority then it may be necessary or lawful for parents to exercise during the non-age of their children, to assume or usurp the same when they have attained the maturity or full exercise of their strength and reason would be tyrannical and unjust. From hence it is evident, that parents have no right to punish the persons of their children more severely than the nature of their wardship requires, much less to invade their lives, to encroach upon their liberty, or transfer them as their property to any master whatsoever.

The first class of duties which parents owe their children respect their natural life; and these comprehend protection, nurture, provision, introducing them into the world in a manner suitable to their rank and fortune, and the like.

The second order of duties regards the intellectual and moral life of their children, or their education in such arts and accomplishments as are necessary to qualify them for performing the duties they owe to themselves and to others. As this was found to be the principal design of the matrimonial alliance, so the fulfilling that design is the most important and dignified of all the parental duties. In order therefore to fit the child for acting his part wisely and worthily as a man, as a citizen, and a creature of God, both parents ought to combine their joint wisdom, authority, and power, and each apart to employ those talents which are the peculiar excellency and ornament of their respective sex. The father ought to lay out and superintend their education, the mother to execute and manage the detail of which she is capable. The former should direct the manly exertion of the intellectual and moral powers of his child. His imagination, and the manner of those exertions, are the peculiar province of the latter. The former should advise, protect, command, and, by his experience, masculine vigour, and that superior authority which is commonly ascribed to his sex, brace and strengthen his pupil for active life, for gravity, integrity, and firmness in suffering. The business of the latter is to bend and soften her male pupil, by the charms of her conversation, and the softness and decency of her manners for social

life, for politeness of taste, and the elegant decorums and enjoyments of humanity; and to improve and refine the tenderness and modesty of her female pupil, and form her to all those mild domestic virtues which are the peculiar characteristics and ornaments of her sex. To conduct the opening minds of their sweet charge through the several periods of their progress, to assist them in each period, in throwing out the latent seeds of reason and ingenuity, and in gaining fresh accessions of light and virtue; and at length, with all these advantages, to produce the young adventurers upon the great theatre of human life, to play their several parts in the sight of their friends, of society, and mankind!

#### SECT. IV. *Herile and Servile Duty.*

IN the natural course of human affairs it must necessarily happen, that some of mankind will live in plenty and opulence, and others be reduced to a state of indigence and poverty. The former need the labours of the latter, and the latter the provision and support of the former. This mutual necessity is the foundation of that connection, whether we call it *moral* or *civil*, which subsists between masters and servants. He who feeds another has a right to some equivalent, the labour of him whom he maintains, and the fruits of it. And he who labours for another has a right to expect that he should support him. But as the labours of a man of ordinary strength are certainly of greater value than mere food and clothing; because they would actually produce more, even the maintenance of a family, were the labourer to employ them in his own behalf; therefore he has an undoubted right to rate and dispose of his service for certain wages above mere maintenance; and if he has incautiously disposed of it for the latter only, yet the contract being of the *onerous* kind, he may equitably claim a supply of that deficiency. If the service be specified, the service is bound to that only; if not, then he is to be construed as bound only to such services as are consistent with the laws of justice and humanity. By the voluntary servitude to which he subjects himself, he forfeits no rights by such as are necessarily included in that servitude, and is obnoxious to no punishment but such as a voluntary failure in the service may be supposed reasonably to require. *The offspring of such servants* have a right to that liberty which neither they nor their parents have forfeited.

As to those who, because of some heinous offence, or for some notorious damage, for which they cannot otherwise compensate, are condemned to perpetual service, they do not, on that account, forfeit all the rights of men; but those, the loss of which is necessary to secure society against the like offences for the future, or to repair the damage they have done.

With regard to captives taken in war, it is barbarous and inhuman to make perpetual slaves of them, unless some peculiar and aggravated circumstances of guilt have attended their hostility. The bulk of the subjects of any government engaged in war may be fairly esteemed innocent enemies; and therefore they have a right to that clemency which is consistent with the common safety of mankind, and the particular security of that society against which they are engaged.

123  
The authority founded on that connection.

134  
Duties of parents.

135  
Education.

136  
The ground of this connection.

137  
The conditions of service.

138  
The case of great offenders.

139  
The case of captives.

Though ordinary captives have a grant of their lives, yet to pay their liberty as an equivalent is much too high a price. There are other ways of acknowledging or returning the favour, than by surrendering what is far dearer than life itself\*. To those who, under pretext of the necessities of commerce, drive the unnatural trade of bargaining for human flesh, and consigning their innocent but unfortunate fellow creatures to eternal servitude and misery, we may address the words of a fine writer; "Let avarice defend it as it will, there is an honest reluctance in humanity against buying and selling, and regarding those of our own species as our wealth and possessions."

#### SECT. V. Social Duties of the private Kind.

HITHERTO we have considered only the domestic economical duties, because these are first in the progress of nature. But as man passes beyond the little circle of a family, he forms connections with relations, friends, neighbours, and others; from whence results a new train of duties of the more private social kind, as *friendship, chastity, courtesy, good-neighbourhood, charity, forgiveness, hospitality.*

140  
Man's aptitude for society.

Man is admirably formed for particular social attachments and duties. There is a peculiar and strong propensity in his nature to be affected with the sentiments and dispositions of others. Men, like certain musical instruments, are set to each other, so that the vibrations or notes excited in one raise correspondent notes and vibrations in the others. The impulses of *pleasure or pain, joy or sorrow*, made on one mind, are by an instantaneous sympathy of nature communicated in some degree to all; especially when hearts are (as an humane writer expresses it) in *unison* of kindness; the joy that vibrates in one communicates to the other also. We may add, that though joy thus imparted swells the harmony, yet grief vibrated to the heart of a friend, and rebounding from thence in sympathetic notes, melts as it were, and almost dies away. All the passions, but especially those of the social kind, are contagious; and when the passions of one man mingle with those of another, they increase and multiply prodigiously. There is a most moving eloquence in the human countenance, air, voice, and gesture, wonderfully expressive of the most latent feelings and passions of the soul, which darts them like a subtle flame into the hearts of others, and raises correspondent feelings there: friendship, love, good-humour, joy, spread through every feature, and particularly shoot from the eyes their softer and fiercer fires with an irresistible energy. And in like manner the opposite passions of hatred, enmity, ill-humour, melancholy, diffuse a sullen and saddening air over the face, and, flashing from eye to eye, kindle a train of similar passions. By these, and other admirable pieces of machinery, men are formed for society and the delightful interchange of friendly sentiments and duties, to increase the happiness of others by participation, and their own by rebound; and to diminish, by dividing the common stock of their misery.

The first emanations of the social principle beyond the bounds of a family lead us to form a nearer conjunction of friendship or good-will with those who are any wife connected with us by *blood, or domestic al-*

*liance.* To them our affection does commonly exert itself in a greater or less degree, according to the nearness or distance of the relation. And this proportion is admirably suited to the extent of our powers and the indigence of our state; for it is only within those lesser circles of confanguinity or alliance that the generality of mankind are able to display their abilities or benevolence, and consequently to uphold their connection with society and suberviency to a public interest. Therefore it is our duty to regard these closer connections as the next department to that of a family, in which nature has marked out for us a sphere of activity and usefulness; and to cultivate the kind affections which are the cement of those endearing alliances.

Frequently the view of distinguishing moral qualities in some of our acquaintance may give birth to that more noble connection we call *FRIENDSHIP*, which is far superior to the alliances of confanguinity. For these are of a superficial, and often of a transitory nature, of which, as they hold more of *instinct* than of *reason*, we cannot give such a rational account. But *friendship* derives all its strength and beauty, and the only existence which is durable, from the qualities of the heart, or from virtuous and lovely dispositions. Or, should these be wanting, they or some shadow of them must be supposed present. Therefore *friendship* may be described to be, "The union of two souls by means of *virtue*, the common object and cement of their mutual affection." Without virtue, or the supposition of it, friendship is only a mercenary league, and alliance of interest, which must dissolve of course when that interest decays or subsists no longer. It is not so much any particular passion, as a composition of some of the noblest feelings and passions of the mind. *Good sense, a just taste and love of virtue, a thorough candour and benignity of heart*, or what we usually call a *good temper*, and a generous sympathy of sentiments and affections, are the necessary ingredients of this virtuous connection. When it is grafted on esteem strengthened by habit, and mellowed by time, it yields infinite pleasure, ever new and ever growing, is a noble support amidst the various trials and vicissitudes of life, and an high seasoning to most of our other enjoyments. To form and cultivate virtuous friendship, must be very improving to the temper, as its principal object is *virtue*, set off with all the allurements of countenance, air, and manners, shining forth in the native graces of many honest sentiments and affections, and rendered *visible* as it were to the friendly spectator in a conduct unaffectedly great and good; and as its principal exercises are the very energies of virtue, or its effect and emanations. So that wherever this amiable attachment prevails, it will exalt our admiration and attachment to virtue, and, unless impeded in its course by unnatural prejudices, run out into a friendship to the human race. For as no one can merit, and none ought to usurp, the sacred name of friend, who hates mankind; so whoever truly loves them, possesses the most essential quality of a true friend.

The duties of friendship are a mutual esteem of each other, unbrided by interest, and independent of it, a generous

\* Hutcheson. Mor. Insi. Phil. lib. 3. c. 3.

142  
Ingredients of friendship.

141  
Duties arising from private relation.

143  
Its duties.

generous confidence its far distant from suspicion as from reserve, an inviolable harmony of sentiments and dispositions of designs and interests, a fidelity unshaken by the changes of fortune, a constancy unalterable by distance of time or place, a resignation of one's personal interest to those of one's friend, and a reciprocal, unvenious, unreverted exchange of kind offices.—But, amidst all the exertions of this moral connection, humane and generous as it is, we must remember that it operates within a narrow sphere, and its immediate operations respect only the individual; and therefore its particular impulses must still be subordinated to a more public interest, or be always directed and controlled by the more extensive connections of our nature.

When our friendship terminates on any of the other sex, in whom beauty or agreeableness of person and external gracefulness of manners conspire to express and heighten the moral charm of a tender honest heart, and sweet, ingenuous modest temper, lighted up by good sense; it generally grows into a more soft and endearing attachment. When this attachment is improved by a growing acquaintance with the worth of its object, is conducted by discretion, and issues at length, as it ought to do, in the moral connection formerly mentioned\*, it becomes the source of many amiable duties, of a communication of passions and interests, of the most refined decencies, and of a thousand nameless deep-felt joys of reciprocal tenderness and love, flowing from every look, word, and action. Here friendship acts with double energy, and the natural conspires with the moral charms to strengthen and secure the love of virtue. As the delicate nature of female honour and decorum, and the inexpressible grace of a chaste and modest behaviour, are the surest and indeed the only means of kindling at first, and ever after of keeping alive, this tender and elegant flame, and of accomplishing the excellent ends designed by it; to attempt by fraud to violate one, or, under pretence of passion, to sully and corrupt the other, and, by so doing, to expose the too often credulous and unguarded object, with a wanton cruelty, to the hatred of her own sex and the scorn of ours, and to the lowest infamy of both is a conduct not only base and criminal, but inconsistent with that truly rational and refined enjoyment, the spirit and quintessence of which is derived from the balmy and sacred charms of virtue kept untainted, and therefore ever alluring to the lover's heart.

*Courtesy, good-neighbourhood, affability, and the like duties, which are founded on our private social connections, are no less necessary and obligatory to creatures united in society, and supporting and supported by each other in a chain of mutual want and dependence. They do not consist in a smooth address, an artificial or obsequious air, fawning adulations, or a polite servility of manners; but in a just and modest sense of our own dignity and that of others, and of the reverence due to mankind, especially to those who hold the higher links of the social chain; in a discreet and manly accommodation of ourselves to the foibles and humours of others; in a strict observance of the rules of decorum and civility; but, above all, in a frank obliging carriage, and generous*

interchange of good deeds rather than words. Such a conduct is of great use and advantage, as it is an excellent security against injury, and the best claim and recommendation to the esteem, civility, and universal respect of mankind. This inferior order of virtues unite the particular members of society more closely, and forms the lesser pillars of the civil fabric; which, in many instances, supply the unavoidable defects of laws, and maintain the harmony and decorum of social intercourse, where the more important and essential lines of virtue are wanting.

*Charity and forgiveness* are truly amiable and useful duties of the social kind. There is a twofold distinction of rights commonly taken notice of by moral writers, *viz. perfect and imperfect*. To fulfil the former, is necessary to the being and support of society; to fulfil the latter, is a duty equally sacred and obligatory, and tends to the improvement and prosperity of society; but as the violation of them is not equally prejudicial to the public good, the fulfilling them is not subjected to the cognizance of law, but left to the candour, humanity, and gratitude of individuals. And by this means ample scope is given to exercise all the generosity, and display the genuine merit and lustre, of virtue. Thus the wants and misfortunes of others call for our charitable assistance and seasonable supplies. And the good man, unconstrained by law, and uncontrolled by human authority, will cheerfully acknowledge and generously satisfy this mournful and moving claim; a claim supported by the sanction of heaven, of whose bounties he is honoured to be the grateful trustee. If his own *perfect* rights are invaded by the injustice of others, he will not therefore reject their *imperfect* right to pity and forgiveness, unless his grant of these should be inconsistent with the more extensive rights of society, or the public good. In that case he will have recourse to public justice and the laws, and even then he will prosecute the injury with no unnecessary severity, but rather with mildness and humanity. When the injury is merely personal, and of such a nature as to admit of alleviations, and the forgiveness of which would be attended with no worse consequences, especially of a public kind, the good man will generously forgive his offending brother. And it is his duty to do so, and not to take private revenge, or retaliate evil for evil. For though resentment of injury is a natural passion, and implanted, as was observed † above, for wise and good ends; yet, considering the manifold partialities which most men have for themselves, was every one to act as judge in his own cause, and to execute the sentence dictated by his own resentment, it is but too evident that mankind would pass all bounds in their fury, and the last sufferer be provoked in his turn to make full reprisals. So that evil, thus encountering with evil, would produce one continued series of violence and misery, and render society intolerable, if not impracticable. Therefore, where the security of the individual, or the good of the public, does not require a proportionable retaliation, it is agreeable to the general law of benevolence, and to the particular end of the passion (which is to prevent injury and the misery occasioned by it) to forgive personal injuries, or not to return evil for evil. This duty is one of the noble refinements

136  
Charity,  
forgiveness.

† See Part I.  
chap. ii.  
and iv.

144  
Love and  
charity.

\* See Sect.  
ii. of this  
chapter.

145  
Courtesy,  
good-  
neighbour-  
hood, &c.

finements which *Christianity* has made upon the general maxims and practice of mankind, and enforced, with a peculiar strength and beauty, by fancies 'no less alluring than awful. And indeed the practice of it is generally its own reward; by expelling from the mind the most dreadful intruders upon its repose, those rancorous passions which are begot and nursed by resentment, and, by disarming, and even subduing, every enemy one has, except such as have nothing left of men but the outward form.

147  
Hospitality.

The most enlarged and humane connection of the private kind seems to be the hospitable alliance, from which flow the amiable and disinterested duties we owe to strangers. If the exercise of passions of the most private and instinctive kind is beheld with moral approbation and delight, how lovely and venerable must those appear which result from a calm philanthropy, are founded in the common rights and connections of society, and embrace men, not of a particular sect, party, or nation, but all in general without distinction, and without any of the little partialities of self-love.

#### SECT. VI. *Social duties of the COMMERCIAL kind.*

148  
Commercial duties.

THE next order of connections are those which arise from the wants and weakness of mankind, and from the various circumstances in which their different situations place them. These we may call *commercial* connections, and the duties which result from them *commercial* duties, as *justice*, *fair-dealing*, *sincerity*, *fidelity to compacts*, and the like.

149  
Their foundation.

Though nature is perfect in all her works, yet she has observed a manifest and eminent distinction among them. To all such as lie beyond the reach of human skill and power, and are properly of her own department, she has given the finishing hand. These man may design after and imitate, but he can never rival them, nor add to their beauty or perfection. Such are the forms and structure of vegetables, animals, and many of their productions, as the honey-comb, the spider's web, and the like. There are others of her works which she has of design left unfinished, as it were, in order to exercise the ingenuity and power of man. She has presented to him a rich profusion of materials of every kind for his convenience and use; but they are rude and unpolished, or not to be come at without art and labour. These therefore he must apply, in order to adapt them to his use, and to enjoy them in perfection. Thus nature has given him an infinite variety of herbs, grain, fossils, minerals, wood, water, earth, air, and a thousand other crude materials, to supply his numerous wants. But he must sow, plant, dig, refine, polish, build, and, in short, manufacture the various produce of nature, in order to obtain even the necessaries, and much more the conveniences and elegancies of life. These then are the price of his labour and industry, and, without that, nature will sell him nothing. But as the wants of mankind are many, and the single strength of individuals small, they could hardly find the necessaries, and much less the conveniences of life, without uniting their ingenuity and strength in acquiring these, and without a mutual intercourse of good offices. Some men are better formed for some kinds of ingenuity

and labour, and others for other kinds; and different soils and climates are enriched with different productions; so that men, by exchanging the produce of their respective labours, and supplying the wants of one country with the superfluities of another, do, in effect, diminish the labours of each, and increase the abundance of all. This is the foundation of all commerce, or exchange of commodities and goods one with another; in order to facilitate which, men have contrived different species of coin, or money, as a common standard by which to estimate the comparative values of their respective goods. But to render commerce sure and effectual, *justice*, *fair-dealing*, *sincerity*, and *fidelity to compacts*, are absolutely necessary.

150  
*Justice, &c.*

*Justice* or *fair-dealing*; or, in other words, a disposition to treat others as we would be treated by them, is a virtue of the first importance, and inseparable from the virtuous character. It is the cement of society, or that pervading spirit which connects its members, inspires its various relations, and maintains the order and subordination of each part to the whole. Without it, society would become a den of thieves and banditti, hating and hated, devouring and devoured, by one another.

151  
*Sincerity.*

*Sincerity*, or *veracity*, in our words and actions, is another virtue or duty of great importance to society, being one of the great bands of mutual intercourse, and the foundation of mutual trust. Without it, society would be the dominion of mistrust, jealousy, and fraud, and conversation a traffic of lies and dissimulation. It includes in it a conformity of our words with our sentiments, a correspondence between our actions and dispositions, a strict regard to truth, and an irreconcilable abhorrence of falsehood. It does not indeed require, that we expose our sentiments indifferently, or tell all the truth in every case; but certainly it does not and cannot admit the least violation of truth, or contradiction to our sentiments. For if these bounds are once passed, no possible limit can be assigned where the violation shall stop; and no pretence of private or public good can possibly counterbalance the ill consequences of such a violation.

152  
*Fidelity to promises, compacts, and engagements, &c.*

*Fidelity to promises, compacts, and engagements*, is likewise a duty of such importance to the security of commerce and interchange of benevolence among mankind, that society would soon grow intolerable without the strict observance of it. *Hobbes*, and others who follow the same track, have taken a wonderful deal of pains to puzzle this subject, and to make all the virtues of this sort merely *artificial*, and not at all *obligatory*, antecedent to human conventions. No doubt, compacts suppose people who make them; and promises, persons to whom they are made; and therefore both suppose some society, more or less, between those who enter into these mutual engagements. But is not a compact or promise binding, till men have agreed that they shall be binding? or are they only binding, because it is our interest to be bound by them, or to fulfil them? Do not we highly approve the man who fulfils them, even though they should prove to be against his interest? and do not we condemn him as a knave who violates them on that account? a promise



mise is a voluntary declaration, by words, or by an action equally significant, of our resolution to do something in behalf of another, or for his service. When it is made, the person who makes it is by all supposed under an obligation to perform it. And he to whom it is made may demand the performance as his right. That perception of *obligation* is a simple idea, and is on the same footing as our other moral perceptions, which may be described by instances, but cannot be defined. Whether we have a perception of such obligation quite distinct from the interest, either public or private, that may accompany the fulfilment of it, must be referred to the conscience of every individual. And whether the mere sense of that obligation, apart from its concomitants, is not a sufficient inducement or motive to keep one's promise, without having recourse to any selfish principle of our nature, must be likewise appealed to the conscience of every honest man. *Fair-dealing and fidelity to compacts* require that we take no advantage of the ignorance, passion, or incapacity of others, from whatever cause that incapacity arises,—that we may be explicit and candid in making bargains, just and faithful in fulfilling our part of them. And if the other party violates his engagements, redress is to be sought from the laws, or from those who are intrusted with the execution of them. In fine, the *commercial* virtues and duties require that we not only do not evade, but maintain the rights of others;—that we be fair and impartial in transferring, bartering, or exchanging property, whether in goods or service; and be inviolably faithful to our word and our engagements, where the matter of them is not criminal, and where they are not extorted by force.

#### SECT. VII. *Social Duties of the POLITICAL Kind.*

WE are now arrived at the last and highest order of duties respecting society, which result from the exercise of the most generous and heroic affections, and are founded on our most enlarged connections.

The *social* principle in man is of such an expansive nature, that it cannot be confined within the circuit of a family, of friends, or a neighbourhood; it spreads into wider systems, and draws men into larger confederacies, communities, and commonwealths. It is in these only that the higher powers of our nature attain the highest improvement and perfection of which they are capable. These principles hardly find objects in the solitary state of nature. There the principle of action rises no higher at farthest than *natural affection* towards one's offspring. There personal or family wants intirely engross the creature's attention and labour, and allow no leisure, or, if they did, no exercise for views and affections of a more enlarged kind. In *solitude* all are employed in the same way, in providing for the *animal* life. And even after their utmost labour and care, single and unaided by the industry of others, they find but a sorry supply of their wants, and a feeble, precarious security against dangers from wild beasts; from inclement skies and seasons; from the mistakes or petulant passions of their fellow-creatures; from their preference of themselves to their neighbours; and from all the little exorbitances of self-love. But in *society*, the mutual aids which men give and receive shorten the labours of

each, and the combined strength and reason of individuals give security and protection to the whole body. There is both a variety and subordination of genius among mankind. Some are formed to lead and direct others, to contrive plans of happiness for individuals, and of government for communities, to take in a public interest, invent laws and arts, and superintend their execution, and, in short, to refine and civilize human life. Others, who have not such good heads, may have as honest hearts, a truly public spirit, love of liberty, hatred of corruption and tyranny, a generous submission to laws, order, and public institutions, and an extensive philanthropy. And others, who have none of those capacities either of heart or head, may be well formed for manual exercises, and bodily labour. The former of these principles have no scope in solitude, where a man's thoughts and concerns do all either centre in himself, or extend no farther than a family; into which little circle all the duty and virtue of the solitary mortal is crowded. But society finds proper objects and exercises for every genius, and the noblest objects and exercises for the noblest geniuses, and for the highest principles in the human constitution; particularly for that warmest and most divine passion which God hath kindled in our bosoms, the inclination of doing good, and reverencing our nature; which may find here both employment, and the most exquisite satisfaction. In society, a man has not only more leisure, but better opportunities, of applying his talents with much greater perfection and success, especially as he is furnished with the joint advice and assistance of his fellow-creatures, who are now more closely united one with the other, and sustain a common relation to the same moral system or community. This then is an object proportioned to his most enlarged social affections, and in serving it he finds scope for the exercise and refinement of his highest intellectual and moral powers. *Therefore society, or a state of civil government, rests on these two principal pillars, "That in it we find security*

" *against those evils which are unavoidable in solitude*

" *—and obtain those goods, some of which cannot be*

" *obtained at all, and others not so well, in that state*

" *where men depend solely on their individual sagacity and industry."*

From this short detail it appears, that *man is a social creature, and formed for a social state*; and that *society*, being adapted to the higher principles and destinations of his nature, must of necessity be his *natural state*.

The duties suited to that state, and resulting from those principles and destinations, or, in other words, duties from our social passions and social connections, or relation to a public system, are, *love of our country, resignation and obedience to the laws, public spirit, love of liberty, sacrifice of life and all to the public, and the like.*

*Love of our country*, is one of the noblest passions that can warm and animate the human breast. It includes all the limited and particular affections to our parents, friends, neighbours, fellow-citizens, countrymen. It ought to direct and limit their more confined and partial actions within their proper and natural bounds, and never let them inroach on those sacred

and first regards we owe to the great public to which we belong. Were we solitary creatures, detached from the rest of mankind, and without any capacity of comprehending a *public interest*, or without affections leading us to desire and pursue it, it would not be our duty to mind it, nor criminal to neglect it. But as we are PARTS of the *public system*, and are not only capable of taking in large views of its interests, but by the strongest affections connected with it, and prompted to take a share of its concerns, we are under the most sacred ties to prosecute its security and welfare with the utmost ardour, especially in times of public trial. This *love of our country* does not import an attachment to any particular soil, climate, or spot of earth, where perhaps we first drew our breath, though those *natural ideas* are often associated with the *moral ones*; and, like external signs or symbols, help to ascertain and bind them; but it imports an affection to that *moral system*, or *community*, which is governed by the same laws and magistrates, and whose several parts are variously connected one with the other, and all united upon the bottom of a common interest. Perhaps indeed every member of the community cannot comprehend so large an object, especially if it extends through large provinces, and over vast tracts of land; and still less can he form such an idea, if there is no *public, i. e.* if all are subject to the caprice and unlimited will of one man; but the preference the generality shew to their native country; the concern and longing after it which they express, when they have been long absent from it; the labours they undertake, and sufferings they endure, to save or serve it; and the peculiar attachment they have to their countrymen; evidently demonstrate that the passion is *natural*, and never fails to exert itself when it is fairly engaged from foreign clogs, and is directed to its proper object. Wherever it prevails in its genuine vigour and extent, it swallows up all forbidding and selfish regards, it conquers the love of *safety, power, pleasure, and wealth*; nay, when the amiable partialities of *friendship, gratitude, private affection, or regards to a family*, come in competition with it, it will teach us bravely to sacrifice all, in order to maintain the rights, and *promote or defend* the honour and happiness of our country.

156  
Resignation and obedience to the laws, &c.

*Resignation and obedience to the laws and orders* of the society to which we belong, are *political duties* necessary to its very being and security, without which it must soon degenerate into a state of licence and anarchy. The welfare, nay, the nature of civil society, requires, that there should be a subordination of orders, or diversity of ranks and conditions in it;—that certain men, or orders of men, be appointed to superintend and manage such affairs as concern the public safety and happiness;—that all have their particular provinces assigned them;—that such a subordination be settled among them as none of them may interfere with another; and finally, that certain *rules or common measures of action* be agreed on, by which each is to discharge his respective duty to govern or be governed, and all may concur in securing the order, and promoting the felicity, of the whole political body. Those *rules of action* are the *laws* of the community, and those different *orders* are the several of-

ficers or magistrates appointed by the public to explain them, and superintend or assist in their execution. In consequence of this settlement of things, it is the duty of each individual to obey the laws enacted, to submit to the executors of them with all due deference and homage, according to their respective ranks and dignity, as to the keepers of the public peace, and the guardians of public liberty; to maintain his own rank, and perform the functions of his own station, with diligence, fidelity, and incorruption. The superiority of the *higher orders*, or the authority with which the state has invested them, in title them, especially if they employ their authority well, to the obedience and submission of the *lower*, and to a proportionable honour and respect from all. The subordination of the lower ranks claims protection, defence, and security from the higher. And the laws, being superior to all, require the obedience and submission of all, being the last resort, beyond which there is no decision or appeal.

*Public spirit, heroic zeal, love of liberty*, and the other *political duties*, do, above all others, recommend those who practise them to the admiration and homage of mankind; because, as they are the offspring of the noblest minds, so are they the parents of the greatest blessing to society. Yet, exalted as they are, it is only in equal and free governments where they can be exercised and have their due effect. For there only does a true *public spirit* prevail, and there only is the *public good* made the standard of the civil constitution. As the end of society is the *common interest and welfare* of the people associated, this end must of necessity be the *supreme law or common standard*, by which the particular rules of action of the several members of the society towards each other are to be regulated. But a *common interest* can be no other than that which is the result of the *common reason or common feelings* of all. Private men, or a particular order of men, have interests and feelings peculiar to themselves, and of which they may be good judges; but these may be separate from, and often contrary to, the interests and feelings of the rest of the society; and therefore they can have no right to make, and much less to impose, laws on their fellow-citizens, inconsistent with, and opposite to, those interests and those feelings. Therefore, a *society, a government, or real public*, truly worthy the name, and not a confederacy of banditti, a clan of lawless savages, or a band of slaves under the whip of a master, must be such a one as consists of freemen, chusing or consenting to laws themselves; or, since it often happens that they cannot assemble and act in a *collective* body, delegating a sufficient number of *representatives, i. e.* such a number as shall most fully comprehend, and most equally represent, their *common feelings* and *common interests*, to digest and vote laws for the conduct and control of the whole body, the most agreeable to those common feelings and common interests.

A *society* thus constituted by *common reason*, and formed on the plan of a *common interest*, becomes immediately an object of public attention, public veneration, public obedience, a public and inviolable attachment, which ought neither to be seduced by bribes, nor

157  
Foundation of public spirit, love of liberty, &c.

158  
Political duties of every citizen.

nor awed by terrors; an object, in fine, of all those extensive and important duties which arise from glorious a confederacy. To watch over such a system; to contribute all he can to promote its good by his reason, his ingenuity, his strength, and every other ability, whether natural or acquired; to resist, and, to the utmost of his power, defeat every encroachment upon it, whether carried on by a secret corruption, or open violence; and to sacrifice his ease, his wealth, his power, nay life itself, and, what is dearer still, his family and friends, to defend or save it, is the duty, the honour, the interest, and the happiness of every citizen; it will make him venerable and beloved while he lives, be lamented and honoured if he falls in so glorious a cause, and transmit his name with immortal renown to the latest posterity.

As the PEOPLE are the fountain of power and authority, the original seat of majesty, the authors of laws, and the creators of officers to execute them; if they shall find the power they have conferred abused by their trustees, their majesty violated by tyranny or by usurpation, their authority prostituted to support violence or sreen corruption, the laws grown pernicious through accidents unforeseen or unavoidable, or rendered ineffectual through the infidelity and corruption of the executors of them; then it is their right, and what is their right is their duty, to refuse that delegated power, and call their trustees to an account; to resist the usurpation, and extirpate the tyranny; to restore their sullied majesty and prostituted authority; to suspend, alter, or abrogate those laws, and punish their unfaithful and corrupt officers. Nor is it the duty only of the united body; but every member of it ought, according to his respective rank, power, and weight in the community, to concur in advancing and supporting those glorious designs.

#### CHAPTER IV. Duty to GOD.

OF all the relations which the human mind sustains, that which subsists between the Creator and his creatures, the supreme Lawgiver and his subjects, is the highest and the best. This relation arises from the nature of a creature in general, and the constitution of the human mind in particular; the noblest powers and affections of which point to an universal mind, and would be imperfect and abortive without such a direction. How lame then must that system of morals be, which leaves a Deity out of the question! How disconsolate, and how desolate of its firmest support!

It does not appear, from any true history, or experience of the mind's progress, that any man, by any formal deduction of his discursive power, ever reasoned himself into the belief of a God. Whether such a belief is only some natural anticipation of soul, or is derived from father to son, and from one man to another, in the way of tradition, or is suggested to us in consequence of an immutable law of our nature, on beholding the august aspect and beautiful order of the universe, we will not pretend to determine. What seems most agreeable to experience is, that a sense of its beauty and grandeur, and the admirable fitness of one thing to another in its vast apparatus, leads the mind necessarily and unavoidably to a perception of

design, or of a designing cause, the origin of all, by a progress as simple and natural as that by which a beautiful picture, or a fine building, suggests to us the idea of an excellent artist. For it seems to hold universally true, that wherever we discern a tendency, or co-operation of things towards a certain end, or producing a common effect, there, by a necessary law of association, we apprehend design, a designing energy or cause. No matter whether the objects are natural or artificial, still that suggestion is unavoidable, and the connection between the effect and its adequate cause obtrudes itself on the mind, and it requires no nice search or elaborate deduction of reason, to trace or prove that connection. We are particularly satisfied of its truth in the subject before us by a kind of direct intuition, and we do not seem to attend to the maxim we learn in schools, "That there cannot be an infinite series of causes and effects producing and produced by one another." Nor do we feel a great accession of light and conviction after we have learned it. We are conscious of our existence, of thought, sentiment, and passion, and sensible wishal that these came not of ourselves; therefore we immediately recognise a parent-mind, an original intelligence, from whom we borrowed those little portions of thought and activity. And while we not only feel kind affections in ourselves, and discover them in others, but likewise behold round us such a number and variety of creatures, endued with natures nicely adjusted to their several stations and economies, supporting and supported by each other, and all sustained by a common order of things, and sharing different degrees of happiness according to their respective capacities, we are naturally and necessarily led up to the Father of such a numerous offspring, the fountain of such wide-spread happiness. As we conceive this Being before all, above all, and greater than all, we naturally, and without reasoning, ascribe to him every kind of perfection, wisdom, power, and goodness without bounds, existing through all time, and pervading all space. We apply to him those glorious epithets of our Creator, Preserver, Benefactor, the supreme Lord and Lawgiver of the whole society of rational and intelligent creatures. Not only the imperfections and wants of our being and condition, but some of the noblest instincts and affections of our minds, connect us with this great and universal nature. The mind, in its progress from object to object, from one character and prospect of beauty to another, finds some blemish or deficiency in each, and soon exhausts, or grows weary and dissatisfied with its subject; it sees no character of excellency among men equal to that pitch of esteem which it is capable of exerting; no object within the compass of human things adequate to the strength of its affection. Nor can it stay any where in this self-expansive progress, or find repose after its highest flights, till it arrives at a Being of unbounded greatness and worth, on whom it may employ its sublimest powers without exhausting the subject, and give scope to the utmost force and fullness of its love without satiety or disgust. So that the nature of this Being corresponds to the nature of man; nor can his intelligent and moral powers obtain their entire end, but on the supposition of such a Being, and without a real sympathy and communication with him.

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The

159, [160]  
Of the people.161  
Divine connections.162  
Existence of God.162  
His relation to the human mind.

The native propensity of the mind to reverence whatever is *great* and *wonderful* in nature, finds a proper object of homage in him who spread out the heavens and the earth, and who sustains and governs the whole of things. The *admiration of beauty, the love of order, and the complacency we feel in goodness*, must rise to the highest pitch, and attain the full vigour and joy of their operations, when they unite in him who is the sum and source of all perfection.

164  
Immorality  
of impiety.

It is evident from the slightest survey of morals, that how punctual soever one may be in performing the duties which result from our relations to mankind, yet to be quite deficient in performing those which arise from our *relation to the Almighty*, must argue a strange perversion of *reason* or depravity of *heart*. If imperfect degrees of worth attract our veneration, and if the want of it would imply an infensibility, or, which is worse, an aversion to merit, what lameness of affection or immorality of character must it be to be unaffected with, and much more to be ill-affected to, a Being of superlative worth! To love society, or particular members of it, and yet to have no sense of our connection with its Head, no affection to our common Parent and Benefactor; to be concerned about the approbation or censure of our fellow-creatures, and yet to feel nothing of this kind towards him who sees and weighs our actions with unerring wisdom and justice, and can fully reward or punish them, betrays equal madness and partiality of mind. It is plain therefore beyond all doubt, that some regards are due to the great Father of all, in whom every lovely and adorable quality combines to inspire veneration and homage.

165  
Right opi-  
nions of  
God.

As it has been observed already, that our *affections* depend on our *opinions* of their objects, and generally keep pace with them, it must be of the highest importance, and seems to be among the first duties we owe to the Author of our being, "to form the least imperfect, since we cannot form perfect, conceptions of his character and administration." For such conceptions, thoroughly imbibed, will render our religion rational, and our dispositions refined. If our opinions are diminutive and distorted, our religion will be superstitious, and our temper abject. Thus, if we ascribe to the Deity that false majesty which consists in the unbenevolent and sullen exercise of mere will or power, or suppose him to delight in the prostrations of servile fear, or as servile praise, he will be worshipped with mean adulation, and a profusion of compliments. Farther, if he be looked upon as a stern and implacable Being, delighting in vengeance, he will be adored with pompous offerings, sacrifices, or whatever else may be thought proper to soothe and mollify him. But if we believe *perfect goodness* to be the character of the supreme Being, and that he loves those most who resemble him most, the worship paid him will be rational and sublime, and his worshippers will seek to please him by imitating that goodness which they adore. The foundation then of all true religion is a *rational faith*. And of a rational faith there seem to be the chief articles, to believe, "that an infinite all-perfect Mind exists, who has no opposite nor any separate interest from that of his creatures;—that he superintends and governs all

166  
Rational  
faith.

creatures and things;—that his goodness extends to all his creatures, in different degrees indeed, according to their respective natures, but without any partiality or envy;—that he does every thing for the best, or in a subserviency to the perfection and happiness of the whole;—particularly, that he directs and governs the affairs of men,—inspects their actions,—distinguishes the good from the bad,—loves and befriends the former,—is displeas'd with, and pities the latter in this world,—and will, according to their respective deserts, reward one and punish the other in the next;—that, in fine, he is always carrying on a scheme of virtue and happiness through an unlimited duration,—and is ever guiding the universe, through its successive stages and periods, to higher degrees of perfection and felicity." This is true *Theism*, the glorious scheme of divine faith; a scheme exhibited in all the works of God, and executed through his whole administration.

This faith, well founded and deeply felt, is nearly connected with a *true moral taste*, and hath a powerful efficacy on the temper and manners of the thief. He who admires goodness in others, and delights in the practice of it, must be conscious of a reigning order within, a rectitude and candour of heart, which disposes him to entertain favourable apprehensions of men, and, from an impartial survey of things, to presume that *good order* and *good meaning* prevail in the universe; and if good meaning and good order, then an *ordering, an intending mind*, who is no enemy, no tyrant to his creatures, but a *friend, a benefactor, an indulgent sovereign*. On the other hand, a bad man, having nothing goodly or generous to contemplate within, no right intentions, nor honesty of heart, suspects every person and every thing, and, beholding nature through the gloom of a selfish and guilty mind, is either averse to the belief of a reigning order, or, if he cannot suppress the unconquerable anticipations of a governing mind, he is prone to tarnish the beauty of nature, and to impute malevolence, or blindness and impotence at least, to the Sovereign Ruler. He turns the universe into a forlorn and horrid waste, and transfers his own character to the Deity, by ascribing to him that uncommunicative grandeur, that arbitrary or revengeful spirit, which he affects or admires in himself. As such a temper of mind naturally leads to *atheism*, or to a *superstition* full as bad; therefore, as far as that temper depends on the unhappy creature in whom it prevails, the propensity to atheism or superstition consequent thereto must be *immoral*. Farther, if it be true that the belief or sense of a Deity is natural to the mind, and the evidence of his existence reflected from his works so full as to strike even the most superficial observer with conviction, then the supplanting or corrupting that sense, or the want of due attention to that evidence, and, in consequence of both, a *supine ignorance* or *affected unbelief* of a Deity, must argue a bad temper, or an immoral turn of mind. In the case of invincible ignorance, or a very bad education, though nothing can be concluded directly against the character; yet whenever ill passions and habits pervert the judgment, and by perverting the judgment terminate in atheism, then the case becomes plainly criminal.

167  
Morality  
of theism.

168  
Immorality  
of atheism.

169  
The con-  
science of  
virtue.

But let casuists determine this as they will, a true faith in the divine character and admiration is generally the consequence of a virtuous state of mind. The man who is truly and habitually good feels the *love of order, of beauty, and goodness*, in the strongest degree; and therefore cannot be insensible to those emanations of them which appear in all the works of God, nor help loving their supreme source and model. He cannot but think, that he who has poured such beauty and goodness over all his works, must himself delight in beauty and goodness, and what he delights in must be both amiable and happy. Some indeed there are, and it is pity there should be any such, who, through the unhappy influence of a wrong education, have entertained dark and unfriendly thoughts of a Deity and his administration, though otherwise of a virtuous temper themselves. However, it must be acknowledged, that such sentiments have, for the most part, a bad effect on the temper; and when they have not, it is because the depraved affections of an honest heart are more powerful in their operation than the speculative opinions of an informed head.

170  
Duties of  
love, &c.

But wherever right conceptions of the Deity and his providence prevail, when he is considered as the inexhausted source of light and joy, and as acting in the joint character of a *Father and Governor*, imparting an endless variety of capacities to his creatures, and supplying them with every thing necessary to their full completion and happiness, what veneration and gratitude must such conceptions, thoroughly believed, excite in the mind? How natural and delightful must it be to one whose heart is open to the perception of truth, and of every thing *fair, great, and wonderful* in nature, to contemplate and adore him who is the first *fair*, the first *great*, and first *wonderful*; in whom *wisdom, power, and goodness* dwell vitally, essentially, originally, and act in perfect concert? What *grandeur* is here to fill the most enlarged capacity, what *beauty* to engage the most ardent love, what a mass of *wonders* in such exuberance of perfection to astonish and delight the human mind through an un-fading duration!

171  
Other affec-  
tions.

If the Deity is considered as our supreme *Guardian and Benefactor*, as the *Father of Mercies*, who loves his creatures with infinite tenderness, and in a particular manner all good men, nay, all who delight in goodness, even in its most imperfect degrees; what resignation, what dependence, what generous confidence, what hope in God and his all-wise providence, must arise in the soul that is possessed of such amiable views of him? All those exercises of piety, and above all a superlative esteem and love, are directed to God as to their *natural, their ultimate*, and indeed their only *adequate* object; and though the immense obligations we have received from him may excite in us more lively feelings of divine goodness than a general and abstracted contemplation of it, yet the affections of *gratitude and love* are of themselves of the generous disinterested kind, not the result of self-interest, or views of reward. A perfect character, in which we always suppose infinite goodness, guided by unerring wisdom, and supported by Almighty power is the proper object of perfect love; and though that character sustains to us the relation of a *Benefactor*, yet the mind,

deeply struck with that perfection, is quite lost amidst such a blaze of beauty, and grows as it were insensible to those minuter irradiations of it upon itself. To talk therefore of a *supererogatory* love of God, or which has *fear* for its principal ingredient, is equally impious and absurd. If we do not love the loveliest object in the universe for his own sake, no prospect of good or fear of ill can ever bribe our esteem, or captivate our love. These affections are too noble to be bought or sold; or bartered in the way of *gain; worth, or merit*, is their object, and their reward is something similar in kind. Whoever indulges such sentiments and affections towards the Deity, must be confirmed in the love of virtue, in a desire to imitate its all-perfect pattern, and in a cheerful security that all his great concerns, those of his friends, and of the universe, shall be absolutely safe under the conduct of unerring wisdom and unbounded goodness. It is in his care and providence alone that the good man, who is anxious for the happiness of all, finds perfect serenity, a serenity neither ruffled by partial ill, nor soured by private disappointment.

172  
Repentance,  
&c.

When we consider the unstained purity and absolute perfection of the *divine* nature, and reflect withal on the imperfection and various blemishes of our own, we must sink, or be convinced we ought to sink, into the deepest humility and prostration of soul before him, who is so wonderfully great and holy. When further, we call to mind what low and languid feelings we have of the divine presence and majesty, what insensibility of his fatherly and universal goodness, nay, what ungrateful returns we have made to it, how far we come short of the perfection of his law, and the dignity of our own nature, how much we have indulged in the selfish passions, and how little to the benevolent ones; we must be conscious that it is our duty to repent of a temper and conduct so unworthy our nature, and unbecoming our obligations to its Author, and to resolve and endeavour to act a wiser and better part for the future.

173  
Hopes of  
pardon.

Nevertheless, from the character which his works exhibit of him, from those delays or alleviations of punishment which offenders often experience, and from the merciful tenor of his administration in many other instances, the sincere penitent may entertain good hopes that his Parent and Judge will not be strict to mark iniquity, but will be propitious and favourable to him, if he honestly endeavours to avoid his former practices, and subdue his former habits, and to live in a greater conformity to the divine will for the future. If any doubts or fears should still remain, how far it may be consistent with the rectitude and equity of the divine government to let his iniquities pass unpunished, yet he cannot think it unfeeling to his paternal clemency and wisdom to contrive a method of retrieving the penitent offender, that shall unite and reconcile the majesty and mercy of his government. If reason cannot of itself suggest such a scheme, it gives at least some ground to expect it. But though *natural religion* cannot let in more light and assurance on so interesting a subject, yet it will reach the humble thief to wait with great submission for any farther intimations it may please the supreme Governor to give of his will; to examine with candour and impartiality what-

ever evidence shall be proposed to him of a *divine revelation*, whether that evidence is *natural* or *supernatural*; to embrace it with veneration and cheerfulness, if the evidence is clear and convincing; and finally, if it bring to light any *new relations* or *connections*, *natural religion* will persuade its sincere votary faithfully to comply with the *obligations*, and perform the *duties* which result from those relations and connections. This is *theism*, *piety*, the *completion of morality*!

174  
Worship,  
praise,  
thankgiving.

We must farther observe, that all those affections which we supposed to regard the Deity as their *immediate* and *primary* object, are vital energies of the soul, and consequently exert themselves into act, and, like all other energies, gain strength or greater activity by that exertion. It is therefore our *duty* as well as highest *interest*, often at stated times, and by decent and solemn acts, to contemplate and adore the great Original of our existence, the Parent of all beauty, and of all good; to express our veneration and love by an awful and devout recognition of his perfections, and to evidence our gratitude by celebrating his goodness, and thankfully acknowledging all his benefits. It is likewise our duty, by proper exercises of sorrow and humiliation, to confess our ingratitude and folly; to signify our dependence on God, and our confidence in his goodness, by imploring his blessing and gracious concurrence in assisting the weakness, and curing the corruptions of our nature; and finally, to testify our sense of his authority, and our faith in his government, by devoting ourselves to do his will, and resigning ourselves to his disposal. These duties are not therefore obligatory, because the Deity needs not, or can be profited by them; but as they are apparently *decent* and *moral*, suitable to the relations he sustains of our *Creator*, *Benefactor*, *Lawgiver*, and *Judge*, expressive of our state and obligations; and improving to our tempers, by making us more rational, social, godlike, and consequently more happy.

175  
External  
worship.

We have now considered *INTERNAL* piety, or the *worship of the mind*, that which is in spirit and in truth; we shall conclude the section with a short ac-

count of that which is *EXTERNAL*. *External* worship is founded on the same principles as *internal*, and of as strict moral obligation. It is either *private* or *public*. *Devotion* that is *inward*, or *purely intellectual*, is too spiritual and abstracted an operation for the bulk of mankind. The operations of their minds, such especially as are employed on the most sublime, immaterial objects, must be assisted by their outward organs, or by some help from the imagination; otherwise they will soon be dissipated by sensible impressions, or grow tiresome if too long continued. Ideas are such fleeting things, that they must be fixed; and so subtle, that they must be expressed and delineated, as it were, by sensible marks and images; otherwise we cannot attend to them, nor be much affected by them. *Therefore verbal adoration*, *prayer*, *praise*, *thanksgiving*, and *confession*, are admirable aids to *inward* devotion, fix our attention, compose and enliven our thoughts, impress us more deeply with a sense of the awful presence in which we are, and, by a natural and mechanical sort of influence, tend to heighten those devout feelings and affections which we ought to entertain, and after this manner reduce into formal and explicit act.

This holds true in a higher degree in the case of *public* worship, where the presence of our fellow-creatures, and the powerful contagion of the *social* affections, conspire to kindle and spread the devout flame with greater warmth and energy. To conclude: *As God is the parent and head of the social system*, as he has formed us for a *social state*, as by one we find the best security against the ills of life, and in the other enjoy its greatest comforts, and as, by means of both, our nature attains its highest improvement and perfection; and moreover, as there are *public blessings* and *crimes* in which we all share in some degree, and *public wants* and *dangers* to which all are exposed, it is therefore evident, that the various and solemn offices of *public religion* are duties of indispensable moral obligation, among the best cements of society, the firmest prop of government, and the fairest ornament of both.

176

## P A R T III.

### CHAP. I.

#### Of PRACTICAL ETHICS, or the CULTURE of the MIND.

177  
Dignity  
and importance  
of the  
subject.

WE have now gone through a particular detail of the several duties we owe to *OURSELVES*, to *SOCIETY*, and to *GOD*. In considering the *first* order of duties, we just touched on the methods of acquiring the different kinds of goods which we are led by nature to pursue; only we left the consideration of the method of acquiring the *moral* goods of the mind to a chapter by itself, because of its singular importance. This chapter then will contain a brief enumeration of the arts of acquiring *virtuous habits*, and of eradicating *vicious ones*, as far as is consistent with the brevity of such a work; a subject of the utmost difficulty as well as importance in morals; to which, nevertheless, the least attention has been generally given by

*moral* writers. This will properly follow a detail of duty, as it will direct us to such *means* or *helps* as are most necessary and conducive to the practice of it.

In the first part of this inquiry we traced the order in which the passions shoot up in the different periods of human life. That order is not accidental, or dependent on the caprice of men, or the influence of custom and education; but arises from the original constitution and laws of our nature; of which this is one, *viz.* "That sensible objects make the first and strongest impressions on the mind." These, by means of our outward organs, being conveyed to the mind, become objects of its attention, on which it reflects when the outward objects are no longer present, or, in other words, when the impressions upon the outward organs cease. These objects of the mind's reflection are called *ideas* or *images*. Towards these, by another law of our nature, we are not altogether indifferent;

178

indifferent ; but correspondent movements of *desire* or *aversion*, *love* or *hated* arise, according as the objects, of which they are images or copies, made an agreeable or disagreeable impression on our organs. Those *ideas* and *affections* which we experience in the first period of life, we refer to the *body*, or to *sense* ; and the *taste* which is formed towards them, we call a *sensible*, or a merely *natural taste* ; and the objects corresponding to them we in general call *good* or *pleasant*.

But as the mind moves forward in its course, it extends its views, and receives a new and more complex set of ideas, in which it observes *uniformity*, *variety*, *similitude*, *symetry of parts*, *reference to an end*, *utility*, *grandeur*. These compose a vast train and diversity of *imagery*, which the mind compounds, divides, and moulds into a thousand forms, in the absence of those objects which first introduced it. And this more complicated imagery suggests a new train of *desires* and *affections*, full as it is sprightly and engaging as any which have yet appeared. This whole class of *perceptions* or *impressions* is referred to the *imagination*, and forms an higher taste than the *sensible*, and which has an immediate and mighty influence on the *finer* passions of our nature, and is commonly termed a *fine taste*.

The objects which correspond to this taste we use to call *beautiful*, *great*, *harmonious*, or *wonderful*, or, in general, by the name of *beauty*.

The mind, still pushing onwards and increasing its stock of ideas, ascends from those to an higher species of objects, viz. the *order* and *mutual relations of minds* to each other, their reciprocal *affections*, *characters*, *actions*, and various *aspects*. In these it discovers a *beauty*, a *grandeur*, a *decorum*, more interesting and alluring than in any of the former kinds. These objects, or the images of them passing in review before the mind, do, by a necessary law of our nature, call forth another and nobler set of affections, as *admiration*, *esteem*, *love*, *honour*, *gratitude*, *benevolence*, and others of the like tribe. This class of *perfections*, and their correspondent *affections*, we refer, because of their objects (*manners*), to a *moral sense*, and call the *taste* or *temper* they excite, *moral*. And the objects which are agreeable to this *taste* or *temper* we denominate by the general name of *moral beauty*, in order to distinguish it from the other, which is termed *natural*.

These different sets of *ideas* or *images* are the materials about which the mind employs itself, which it blends, ranges, and diversifies ten thousand different ways. It feels a strong propensity to connect and associate those ideas among which it observes any *similitude* or any *aptitude*, whether *original* and *natural*, or *customary* and *artificial*, to suggest each other. See METAPHYSICS.

But whatever the reasons are, whether *similitude*, *co-existence*, *causality*, or any other *aptitude* or *relation*, why any two or more ideas are connected by the mind at first, it is an established law of our nature, "that when two or more ideas have often started in company, they form so strong an union, that it is very difficult ever after to separate them." Thus the *lover* cannot separate the idea of *merit* from his *wifeness* ; the *courtier* that of *dignity* from his *title*

or *ribbon* ; the *misér* that of *happiness* from his *bag*s. It is these associations of *worth* or *happiness* with any of the different sets of *objects* or *images* before specified, that form our *taste*, or *complex idea of good*. By another law of our nature, "our *affections* follow and are governed by this *taste*. And to these *affections* our *character* and *conduct* are similar and proportioned, on the general tenor of which our *happiness* principally depends."

As all our *leading* passions then depend on the direction which our *taste* takes, and as it is always of the same strain with our *leading* associations, it is worth while to enquire a little more particularly how these are formed, in order to detect the secret sources from whence our passions derive their principal strength, their various rises and falls. For this will give us the true key to their management, and let us into the right method of correcting the *bad*, and improving the *good*.

No kind of objects make so powerful an impression on us as those which are immediately impressed on our *senses*, or strongly painted on our *imagination*s. Whatever is purely *intellectual*, as abstracted or scientific truths, the subtle relations and differences of things, has a fainter sort of existence in the mind ; and, though it may exercise and whet the *memory*, the *judgment*, or the *reasoning power*, gives hardly any impulse at all to the *active* powers, the *passions*, which are the main springs of motion. On the other hand, were the mind intirely under the direction of *sense*, and impassible only by such objects as are present, and strike some of the outward organs, we should then be precisely in the state of the brute creation, and be governed solely by *instinct* or *appetite*, and have no power to controul whatever impressions are made upon us : Nature has therefore endued us with a *middle faculty*, wonderfully adapted to our *mixed* state, which holds partly of *sense* and partly of *reason*, being strongly allied to the *former*, and the common receptacle in which all the notices that come from that quarter are treasured up ; and yet greatly subservient and ministerial to the *latter*, by giving a body, a coherence, and beauty to its conceptions. This *middle* faculty is called the *imagination*, one of the most busy and fruitful powers of the mind. Into this common storehouse are likewise carried all those *moral images* or *forms* which are derived from our *moral faculties* of perception ; and there they often undergo new changes and appearances, by being mixed and wrought up with the images and forms of *sensible* or *natural* things. By this coalition of *imagery*, *natural beauty* is dignified and heightened by *moral qualities* and *perfections*, and *moral qualities* are at once exhibited and set off by *natural beauty*. The *sensible* beauty, or *good*, is refined from its dross by partaking of the *moral* ; and the *moral* receives a stamp, a visible character and currency, from the *sensible*.

As we are first of all accustomed to *sensible* impressions and *sensible* enjoyments, we contract early a *sensual relish*, or *love of pleasure*, in the lower sense of the word. In order however to justify this relish, the mind, as it becomes open to *higher* perceptions of *beauty* and *good*, borrows from thence a noble set of *images*, as *fine taste*, *generosity*, *social affections*, *friendship*,

179  
Ideas of beauty and a fine taste.

180  
Moral ideas and a moral taste.

181  
Sources of association.

182  
Laws of association.

183  
Leading passions follow taste.

184  
The improved life of the imagination.

185  
Its energy in various instances in heightening sensible pleasures.

ship, good fellowship, and the like; and, by dressing out the old pursuits with these new ornaments, gives them an additional dignity and lustre. By these ways the desire of a table, love of finery, intrigue, and pleasure, are vastly increased beyond their natural pitch, having an impulse combined of the force of the natural appetites, and of the superadded strength of those passions which tend to the moral species. When the mind becomes more sensible to those objects or appearances in which it perceives beauty, uniformity, grandeur, and harmony, as fine cloaths, elegant furniture, plate, pictures, gardens, houses, equipage, the beauty of animals, and particularly the attractions of the sex; to these objects the mind is led by nature, or taught by custom, the opinion and example of others, to annex certain ideas of moral character, dignity, decorum, honour, liberality, tenderness, and active or social enjoyment. The consequence of this association is, that the objects to which these are annexed must live in their value, and be pursued with proportionate ardour. The enjoyment of them is often attended with pleasure; and the mere possession of them, where that is wanting, frequently draws respect from one's fellow-creatures: This respect is, by many, thought equivalent to the pleasure of enjoyment. Hence it happens that the idea of happiness is connected with the mere possession, which is therefore eagerly sought after, without any regard to the generous use or honourable enjoyment. Thus the passion, resting on the means, not the end, i. e. losing sight of its natural object, becomes wild and extravagant.

187  
In raising the value of external symbols, &c.

In fine, any object, or external denomination, a staff, a garter, a cup, a crown, a title, may become a moral badge or emblem of merit, magnificence, or honour, according as these have been found or thought, by the possessors or admirers of them, to accompany them; yet, by the deception formerly mentioned, the merit or the conduct which intitled, or should intitle, to those marks of distinction, shall be forgot or neglected, and the badges themselves be passionately affected or pursued, as including every excellency. If these are attained by any means, all the concomitants which nature, custom, or accidents have joined to them, will be supposed to follow of course. Thus, moral ends, with which the unhappy admirer is apt to colour over his passion and views, will, in his opinion, justify the most immoral means, as prostitution, adulation, fraud, treachery, and every species of knavery, whether more open or more disguised.

188  
In heightening the value of wealth, power, &c.

When men are once engaged in active life, and find that wealth and power, generally called INTEREST, are the great avenues to every kind of enjoyment, they are apt to throw in many engaging moral forms to the object of their pursuit, in order to justify their passion, and varnish over the measures they take to gratify it, as independency on the vices or passions of others, provision and security to themselves and friends, prudent economy, or well-placed charity, social communication, superiority to their enemies, who are all villains, honourable service, and many other ingredients of merit. To attain such capacities of usefulness or enjoyment, what arts, nay, what meannesses, can be thought blameable by those cool pursuers of interest!—Nor have they whom the gay world is

pleased to indulge with the title of men of pleasure their imaginations less pregnant with moral images, with which they never fail to ennoble, or, if they cannot do that, to palliate their gross pursuits. Thus admiration of wit, of sentiments and merit, friendship, love, generous sympathy, mutual confidence, giving and receiving pleasure, are the ordinary ingredients with which they season their gallantry and pleasurable entertainments; and by which they impose on themselves, and endeavour to impose on others, that their amours are the joint issue of good sense and virtue.

These associations, variously combined and proportioned by the imagination, form the chief private passions, which govern the lives of the generality, as the love of action, of pleasure, power, wealth, and fame; they influence the desirous, and affect the public passions, and raise joy or sorrow as they are gratified or disappointed. So that in effect these associations of good and evil, beauty and deformity, and the passions they raise, are the main hinges of life and manners, and the great sources of our happiness or misery. It is evident, therefore, that the whole of moral culture must depend on giving a right direction to the leading passions, and duly proportioning them to the value of the objects or goods pursued, under what name soever they may appear.

189  
Its influence on all the passions.

Now, in order to give them this right direction and due proportion, it appears, from the foregoing detail, that those associations of ideas, upon which the passions depend, must be duly regulated; that is to say, as an exorbitant passion for wealth, pleasure, or power, flows from an association or opinion that more beauty and good, whether natural or moral, enters into the enjoyment or possession of them, than really belongs to either; therefore, in restoring those passions to their just proportion, we must begin with correcting the opinion, or breaking the false association, or, in other words, we must decompose the complex phantom of happiness or good, which we fondly admire; disunite those ideas that have no natural alliance; and separate the original idea of wealth, power, or pleasure, from the foreign mixtures incorporated with it, which enhance its value, or give it its chief power to enchant and seduce the mind. For instance, let it be considered how poor and inconsiderable a thing wealth is, if it be disjoined from real use, or from ideas of capacity in the possessor to do good, from independency, generosity, provision for a family or friends, and social communication with others. By this standard let its true value be fixed; let its misapplication, or unbenignant enjoyment, be accounted fordid and infamous; and nothing worthy or estimable be ascribed to the mere possession of it, which is not borrowed from its generous use.

190  
Moral culture, by correcting our taste or imagination.

If that complex form of good which is called pleasure engage us, let it be analysed into its constituent principles, or those allurements it draws from the heart and imagination, in order to heighten the low part of the indulgence; let the separate and comparative moment of each be distinctly ascertained and deduced from that gross part, and this remainder of the accumulated enjoyment will dwindle down into a poor, insipid, transitory thing. In proportion as the opinion of the good pursued abates, the admiration must decay, and

191  
By selfishness, and a counter-process.



and the *passions* lose strength of course. One effectual way to lower the *opinion*, and consequently to weaken the habit founded on it, is to practise lesser pieces of self-denial, or to abstain, to a certain pitch, from the pursuit or enjoyment of the favourite object; and, that this may be the more easily accomplished, one must avoid those occasions, that company, those places, and the other circumstances, that enflamed one and endeared the *other*. And, as a *counter-process*, let *higher* or even *different* enjoyments be brought in view, other passions played upon the former, different places frequented, other exercises tried, company kept with persons of a different or more correct way of thinking, both in *natural* and *moral* subjects.

As much depends on our letting out well in life, let the *youthful* fancy, which is apt to be very florid and luxuriant, be early accustom'd by *instruction*, *example*, and significant *moral exercises*, nay, by looks, gestures, and every other testimony of just approbation or blame, to annex ideas of *merit*, *honour*, and *happiness*; not to *birth*, *dress*, *rank*, *beauty*, *fortune*, *power*, *popularity*, and the like *outward* things, but to *moral* and *truly virtuous qualities*, and to those *enjoyments* which spring from a well-informed judgment and a regular conduct of the affections, especially those of the *social* and *disinterested* kind. Such dignified forms of *beauty* and *good*, often suggested, and, by moving pictures and examples, warmly recommended to the *imagination*, enforced by the authority of *conscience*, and demonstrated by *reason* to be the surest means of enjoyment, and the only independent, undeprivable, and durable goods, will be the best counterbalance to meaner passions, and the firmest foundation and security to virtue.

It is of great importance to the forming a *just taste*, or pure and large conceptions of happiness, to study and understand *human nature* well, to remember what a complicated system it is, particularly to have deeply imprinted on our mind that GRADATION of *senses*, *faculties*, and *powers of enjoyment* formerly mentioned, and the *sub-ordination* of goods resulting from thence, which nature points out, and the experience of mankind confirms; who, when they think seriously, and are not under the immediate influence of some violent prejudice or passion, prefer not the pleasures of *action*, *contemplation*, *society*, and most *exercises* and *joys* of the moral kind, as *friendship*, *natural affection*, and the like, to all *sensical* gratifications whatsoever? where the different species of pleasure are blended into *one complex form*, let them be accurately distinguished, and be referred each to its proper *faculty* and *sense*, and examined apart what they have peculiar, what common with others, and what foreign and adventitious. Let *wealth*, *grandeur*, *luxury*, *love*, *vanity*, and the like, be tried in this test, and their true alloy will be found out.—Let it be farther considered, whether the mind may not be easy and enjoy itself greatly, though it want many of those elegancies and superfluities of life which some possess, or that load of wealth and power which others eagerly pursue, and under which they groan. Let the difficulty of attaining, the precariousness of possessing, and the many abatements in enjoying, overgrown wealth and envied greatness, of which the weary possessors so fre-

quently complain, as the hurry of business, the burden of company, of paying attendance to the *few*, and giving it to the *many*, the cares of keeping, the fears of losing, and the desires of increasing what they have, and the other troubles which accompany this pitiful drudgery and pompous servitude; let these and the like circumstances be often consider'd, that are conducive to the removing or lessening the *opinion* of such goods, and the attendant *passion* or *set* of *passions* will decay of course.

Let the peculiar bent of our nature and character be observed, whether we are most inclined to form affections and relish objects of the *sensible*, *intellectual*, or *moral* kind. Let that which has the ascendant be particularly watched, let it be directed to right objects, be improved by proportioned exercises, and guarded by proper checks from an opposite quarter. Thus the *sensible* turn may be exalted by the *intellectual*, and a taste for the beauty of the *fine arts*, and both may be made subservient to convey and rivet sentiments highly *moral* and *public-spirited*. This inward survey must extend to the *strength* and *weaknesses* of one's nature, one's *conditions*, *connections*, *habitudes*, *fortune*, *studies*, *acquaintance*, and the other circumstances of one's life, from which every man will form the justest estimate of his own dispositions and character, and the best rules for correcting and improving them. And in order to do this with more advantage, let those *times* or *critical seasons* be watch'd when the mind is best dispos'd towards a change; and let them be improved by rigorous *resolutions*, *promises*, or whatever else will engage the mind to persevere in virtue. Let the *conduct*, in fine, be often reviewed, and the *causes* of its *corruption* or *improvement* be carefully observed.

It will greatly conduce to refine the *moral taste*, and strengthen the *virtuous temper*, to accustom the mind to the frequent exercise of *moral sentiments* and *determinations*, by reading *history*, *poetry*, particularly of the *picturesque* and *dramatic* kind, the study of the *fine arts*; by conversing with the most eminent for good sense and virtue; but, above all, by frequent and repeated acts of *humanity*, *compassions*, *friendship*, *politeness*, and *hospitality*. It is exercise gives health and strength. He that reasons most frequently becomes the wisest, and most enjoys the pleasures of wisdom. He who is most often affected by objects of compassions in *poetry*, *history*, or *real life*, will have his soul most open to pity, and its delightful pains and duties. So he also who practises most diligently the offices of kindness and charity, will by it cultivate that disposition from whence all his pretensions to personal merit must arise, his present and his future happiness.

An useful and honourable employment in life will greatly strengthen a sense of virtue and good affections, which must be nourish'd by right training, as well as our understandings. For such an employment, by enlarging one's experience, giving an habit of attention and caution, or obliging one, from necessity or interest, to keep a guard over the passions, and study the outward decencies and appearances of virtue, will by degrees produce good habit, and at length in-

195  
By observing our own bent and character, &c.

196  
By frequent moral exercises.

197  
By an honest employment.

192  
By a sound and natural education.

193  
By rightly studying human nature.

194  
By comparing the moment and abatements of different goods.

finuate the love of virtue and honesty for its own sake.

198  
By viewing men and manners in a fair light.

It is a great inducement to the exercise of benevolence to view *human nature* in a favourable light, to observe the characters and circumstances of mankind on the *fairest* sides, to put the best constructions on their actions they will bear, and to consider them as the result of *partial* and *mislaken*, rather than *ill* affections, or, at worst, as the excesses of a pardonable self-love, seldom or never the effect of pure malice.

199  
By consideration and pious exercises.

Above all, the *nature* and *consequences* of *virtue* and *vice*, their consequences being the law of our nature and will of heaven; the light in which they appear to our supreme *Parent* and *Lawgiver*, and the reception they will meet with from him, must be often attended to. The exercises of *piety*, as *adoration*, and *praise* of the *divine* excellency, *invocation* and *dependence* on his aid, *confession*, *thanksgiving*, and *resignation*, are habitually to be indulged, and frequently performed, not only as *medicinal*, but highly *improving* to the temper.

200  
By just views of human life and its connection with a future.

To conclude: it will be of admirable efficacy towards eradicating *bad* habits, and implanting *good* ones, frequently to contemplate *human life* as the great *nursery* of our *future* and *immortal* existence, as that *state* of probation in which we are to be educated for a *divine* life. To remember, that our *virtues* or *vices* will be *immortal* as ourselves, and influence our *future* as well as our *present* happiness,—and therefore, that every disposition and action is to be regarded as pointing beyond the *present* to an *immortal* duration. An habitual attention to this wide and important *connection* will give a vast compass and dignity to our sentiments and actions, a noble superiority to the pleasures and pains of life, and a generous ambition to make our *virtue* as *immortal* as our *being*.

#### CHAPTER II.

##### MOTIVES TO VIRTUE from Personal HAPPINESS.

201  
Motives from personal happiness.

WE have already considered our *obligations* to the practice of *virtue*, arising from the *constitution* of our nature, by which we are led to approve a certain *order* and *economy* of *affections*, and a certain *course* of *action* correspondent to it\*.—But, besides this, there are several motives which strengthen and secure virtue, though not themselves of a *moral* kind. These are, its *tendency* to *personal* happiness, and the *contrary* tendency of *vice*. \* Personal happiness arises “either from the state of a man’s own mind, or from “the state and disposition of external causes towards “him.”

202  
Happiness of virtue from within

We shall first examine the “tendency of virtue to “happiness with respect to the state of a man’s own “mind.”—This is a point of the utmost consequence in morals, because, unless we can convince ourselves, or shew to others, that, by doing our *duty*, or fulfilling our *moral* obligations, we consult the greatest satisfaction of our own mind, or our highest interest on the whole, it will raise strong and often unsurmountable prejudices against the practice of virtue, especially whenever there arises any appearances of *opposition* between our *duty* and our *satisfaction* or *interest*. To

creatures so desirous of happiness, and averse to misery, as we are, and often so odly situated amidst contending passions and interests, it is necessary that virtue appear not only an *honourable*, but a *pleasing* and *beneficent* form. And in order to justify our choice to ourselves as well as before others, we must ourselves feel and be able to avow in the face of the whole world, that *her ways* are *ways* of *pleasantry*, and *her paths* the paths of *peace*. This will shew, beyond all contradiction, that we not only approve, but can give a sufficient reason for what we do.

203  
Influence of vice on the temper of the mind.

Let any man, in a cool hour, when he is disengaged from business, and undisturbed by passion (as such cool hours will sometimes happen) sit down, and seriously reflect with himself what state or temper of mind he would chuse to feel and indulge, in order to be easy and to enjoy himself. Would he chuse, for that purpose, to be in a constant dissipation and hurry of thought; to be disturbed in the exercise of his reason; to have various and often interfering phantoms of good playing before his imagination, soliciting and distracting him by turns, now soothing him with amusing hopes, then torturing him with anxious fears; and to approve this minute what he shall condemn the next? Would he chuse to have a strong and painful sense of every petty injury; quick apprehensions of every impending evil; incessant and insatiable desires of power, wealth, honour, pleasure; an irreconcilable antipathy against all competitors and rivals; insolent and tyrannical dispositions to all below him; fawning, and at the same time envious, dispositions to all above him; with dark suspicions and jealousies of every mortal? Would he chuse neither to love nor be beloved of any; to have no friend in whom to confide, or with whom to interchange his sentiments or designs; no favourite, on whom to bestow his kindness, or vent his passions; in fine, to be conscious of no merit with mankind, no esteem from any creature, no good affection to his Maker, no concern for, nor hopes of, his approbation; but, instead of all these, to hate, and know that he is hated, to condemn, and know that he is condemned by all; by the good, because he is so unlike; and by the bad, because he is so like themselves; to hate or to dread the very Being that made him; and, in short, to have his breast the seat of pride and passion, petulance and revenge, deep melancholy, cool malignity, and all the other furies that ever possessed and tortured mankind?—Would our calm inquirer after happiness pitch on such a state, and such a temper of mind, as the most likely means to put him in possession of his desired ease and self-enjoyment?

Or would he rather chuse a serene and easy flow of thought; a reason clear and composed; a judgment unbiassed by prejudice, and undistracted by passion; a sober and well-governed fancy, which presents the images of things true, and mixed with delusive and unnatural charms, and therefore administers no improper or dangerous fuel to the passions, but leaves the mind free to chuse or reject, as becomes a reasonable creature; a sweet and sedate temper, not easily ruffled by hopes or fears, prone neither to suspicion nor revenge, apt to view men and things in the fairest light, and to bend gently to the humours of others rather than obstinately to contend with them? Would

204 [207.]  
Influence of virtue on the temper.

he

he choſe ſuch moderation and continence of mind, as neither to be ambitious of power, fond of honours, covetous of wealth, nor a ſlave to pleaſure; a mind of courſe neither elated with ſucceſs, nor dejected with diſappointment; ſuch a modeſt and noble ſpirit as ſupports power without inſolence, wears honour without pride, uſes wealth without profuſion or parcimony; and rejoices more in giving than in receiving pleaſure; ſuch fortitude and equanimity as riſes above miſfortunes, or turns them into bleſſings; ſuch integrity and greatneſs of mind, as neither flatters the vices, nor triumphs over the follies of men; as equally ſpurns ſervitude and tyranny, and will neither engage in low deſigns, nor abet them in others? Would he chooſe, in fine, ſuch mildneſs and benignity of heart as takes part in all the joys, and refuſes none of the ſorrows of others; ſtands well-affected to all mankind; is conſcious of meriting the eſteem of all, and of being beloved by the beſt; a mind which delights in doing good without any ſhew, and yet arrogates nothing on that account; rejoices in loving and being beloved by its Maker, acts ever under his eye, reſigns itſelf to his providence, and triumphs in his approbation?—Which of theſe diſpoſitions would be his choice, in order to be contented, ſerene, and happy?—The former temper is VICE, the latter VIRTUE. Where one prevails, there MISERY prevails, and by the generality is acknowledged to prevail. Where the other reigns, there HAPPINESS reigns, and by the confeſſion of mankind is acknowledged to reign. The perfection of either temper is *miſery or happineſs in perfection*.—THEREFORE, every approach to either extreme is an approach to *miſery, or to happineſs*; i. e. every degree of vice or virtue is accompanied with a proportional degree of *miſery or happineſs*.

<sup>289</sup> The alleviations of his ills. The principal alleviations of a virtuous man's calamities are theſe:—That though ſome of them may have been the effect of his imprudence or weakneſs, yet few of them are ſharpened by a ſenſe of guilt, and none of them by a conſciouſneſs of wickedneſs, which ſurely is their keenest ſting;—that they are common to him with the beſt of men;—that they ſeldom or never attack him quite unprepared, but rather guarded with a conſciouſneſs of his own ſincerity and virtue, with a faith and truſt in providence, and a firm reſignation to its perfect orders;—that they may be improved as means of correction, or materials to give ſcope and ſtability to his virtues;—and, to name no more, they are conſiderably leſſened, and often ſweetened to him, by the general ſympathy of the wife and good.

<sup>290</sup> His enjoyments. His enjoyments are more numerous; or, if leſs numerous, yet more intense than thoſe of the bad man: for he ſhates in the joys of others by rebound; and every increaſe of general or particular happineſs is a real addition to his own. It is true, his friendly ſympathy with others ſubjects him to ſome pains which the hard-hearted wretch does not feel; yet to give a looſe to, it is a kind of agreeable diſcharge. It is ſuch a ſorrow as he loves to indulge; a ſort of pleaſing anguiſh that ſweetly melts the mind, and terminates in a ſelf-approving joy. Though the good man may want means to execute, or be diſappointed in the ſucceſs of, his benevolent purpoſes; yet, as was formerly \* obſerved, he is ſtill conſcious of good affection, and that conſciouſneſs is an enjoyment of a more delightful

favour than the greateſt triumphs of ſucceſsful vice. If the ambitious, covetous, or voluptuous, are diſappointed, their paſſions recoil upon them with a fury proportioned to their opinion of the value of what they purſue, and their hope of ſucceſs; while they have nothing within to balance the diſappointment, unleſs it is an uſeleſs fund of pride, which, however, frequently turns mere accidents into mortifying affronts, and exalts grief into rage and frenzy.—Whereas the meek, humble, and benevolent temper is its own reward, is ſatisfied from within; and, as it magnifies greatly the pleaſure of ſucceſs, ſo it wonderfully alleviates, and in a manner annihilates, all pain for the want of it.

As the good man is conſcious of loving and with-From me- ing well to all mankind, he muſt be ſenſible of his de- rited eſteem rived eſteem and ſympa- ſerving the eſteem and good-will of all; and this ſuppoſed thy. reciprocation of ſocial feelings is, by the very frame of our nature, made a ſource of very intense and enlivening joys. By this ſympathy of affections and intereſts, he feels himſelf intimately united with the human race; and, being ſenſibly alive over the whole ſyſtem, his heart receives and becomes reſponſive to every touch given to any part. So that, as an eminent philoſopher § & Vide finely expreſſes it, he gathers contentment and delight Shaftſb. Inq. into Virtue, Book II. from the pleaſed and happy ſtates of thoſe around him, from accounts and relations of ſuch happineſs, from the very countenances, geſtures, voices, and ſounds even of creatures foreign to our kind, whoſe figuſ of joy and contentment he can any way diſcern.

Nor do thoſe generous affections ſtop any other Do not in- natural ſource of joy whatever, or deaden his ſenſe of intereſt with other joys. an innocent gratification. They rather keep the other joys ſeveral ſenſes and powers of enjoyment open and diſengaged, intense and uncorrupted by riot or abuſe; as is evident to any one who conſiders the diſſipated, unfeeling ſtate of men of pleaſure, ambition, or intereſt, and compares it with the ſerene and gentle ſtate of a mind at peace with itſelf, and friendly to all mankind, unruſhed by any violent emotion, and ſenſible to every good-natured and alluring joy.

It were eaſy, by going through the different ſets of The miſery 212 of exceſs in the private paſſions. affections mentioned formerly †, to ſhew, that it is only by maintaining the proportion ſettled there that the mind arrives at true repoſe and ſatiſfaction. If fear † See Part I. exceeds that proportion, it ſinks into melancholy chap. I. li. dejection. If anger paſſes juſt bounds, it ferments into rage and revenge, or ſubſides into a ſullen corroding gloom, which embitters every good, and renders one exquiſitely ſenſible to every ill. The private paſſions, the love of honour eſpecially, whoſe impulſes are more generous, as its effects are more diffuſive, are instruments of private pleaſure; but if they are diſproportioned to our wants, or to the value of their ſeveral objects, or to the balance of other paſſions equally neceſſary and more amiable, they become instruments of intense pain and miſery. For, being now deſtitute of that counterpoize which held them at a due pitch, they grow turbulent, peeviſh, and revengeful, the cauſe of conſtant reſtleſſneſs and torment, ſometimes flying out into a wild delirious joy, at other times ſettling in a deep ſplenic grief. The concert between reaſon and paſſion is then broke: all is diſſonance and diſtraction within. The mind is out

\* See Part II. chap. ii.

of frame, and feels an agony proportioned to the violence of the reigning passion.

213  
In the public affections.

The case is much the same, or rather worse, when any of the particular *kind* affections are out of their natural order and proportion; as happens in the case of *effeminate pity, exorbitant love, parental dotage*, or any *party-passion*, where the just regards to society are supplanted. The more *social* and *disinterested* the passion is, it breaks out into the wilder excesses, and makes the more dreadful havoc both within and abroad; as is but too apparent in those cases where a false species of *religion, honour, zeal, or party-rage*, has seized on the natural enthusiasm of the mind, and worked it up to madness. It breaks through all ties *natural and civil*, contracts the most sacred and solemn obligations, silences every other affection whether *public or private*, and transforms the most gentle natures into the most savage and inhuman.

214  
Happiness of well-proportioned passions.

Whereas the man who keeps the *balance of affection* even, is easy and serene in his motions; mild, and yet affectionate; uniform and consistent with himself; is not liable to disagreeable collisions of interests and passions; gives always place to the most friendly and humane affections, and never to dispositions or acts of resentment, but on high occasions, when the *security of the private, or welfare of the public system*, or the *great interests of mankind*, necessarily require a noble indignation; and even then he observes a just measure in wrath: and last of all, he proportions every passion to the value of the object he affects, or to the importance of the end he pursues.

215  
Sum of the argument.

To sum up this part of the argument, the *honest and good man* has eminently the advantage of the *knave and selfish wretch* in every respect. The pleasures which the *last* enjoys flow chiefly from external advantages and gratifications; are superficial and transitory; dashed with long intervals of satiety, and frequent returns of remorse and fear; dependent on favourable accidents and conjunctures; and subjected to the humours of men. But the *good man* is satisfied from himself; his principal possessions lie within, and therefore beyond the reach of the caprice of men or fortune; his enjoyments are exquisite and permanent; accompanied with no inward checks to damp them, and always with ideas of dignity and self-approbation; may be tasted at any time, and in any place. The gratifications of *vice* are turbulent and unnatural, generally arising from the relief of passions in themselves intolerable, and issuing in tormenting reflection; often irritated by disappointment, always inflamed by enjoyment, and yet ever cloyed with repetition. The pleasures of *virtue* are calm and natural; flowing from the exercise of kind affections, or delightful reflections in consequence of them; not only agreeable in the prospect, but in the present feeling; they never fatigue, nor lose their relish; nay, rather the admiration of *virtue* grows stronger every day; and not only is the desire but the enjoyment heightened by every new gratification; and, unlike to most others, it is increased, not diminished, by sympathy and communication.—In fine, the satisfactions of *virtue* may be purchased without a bribe, and possessed in the humblest as well as the most triumphant fortune; they can bear the strictest review, do not change with circumstances, nor grow old with time. Force cannot rob,

nor fraud cheat us of them; and, to crown all, instead of abating, they enhance every other pleasure.

But the happy consequences of *virtue* are seen not only in the internal enjoyments it affords a man, but effects of "in the favourable disposition of external causes to-wards him, to which it contributes."

As *virtue* gives the sober possession of one's self, and the command of one's passions, the consequence body, must be heart's ease, and a fine natural flow of spirits, which conduce more than any thing else to health and long life. Violent passions, and the excesses they occasion, gradually impair and wear down the machine, But the calm placid state of a temperate mind, and the healthful exercises in which *virtue* engages her faithful votaries, preserve the natural functions in full vigour and harmony, and exhilarate the spirits, which are the chief instruments of action.

It may by some be thought odd to assert, that *virtue* is no enemy to a man's *fortune* in the present state of things.—But if by *fortune* be meant a moderate or competent share of *wealth, power, or credit*, not overgrown degrees of them; what should hinder the virtuous man from obtaining that? He cannot cringe or fawn, it is true, but he can be civil and obliging as well as the knave; and surely his civility is more alluring, because it has more manliness and grace in it than the mean adulation of the other: he cannot cheat or undermine; but he may be cautious, provident, watchful of occasions, and equally prompt with the rogue in improving them: he fears not prostitute himself as a pander to the passions, or as a tool to the vices, of mankind; but he may have as found an understanding and as good capacities for promoting their real interests as the veriest court-slave: and then he is more faithful and true to those who employ him. In the common course of business, he has the same chances with the knave of acquiring a fortune, and rising in the world. He may have equal abilities, equal industry, equal attention to business; and in other respects he has greatly the advantage of him. People love better to deal with him; they can trust him more; they know he will not impose on them, nor take advantage of them, and can depend more on his word than on the oath or strongest securities of others. Whereas what is commonly called *cunning*, which is the *springing of ignorance*, and constant companion of *knavery*, is not only a mean-spirited, but a very short-sighted talent, and a fundamental obstacle in the road of business. It may procure indeed immediate and petty gains; but it is attended with dreadful abatements, which do more than overbalance them, both as it sinks a man's credit when discovered, and cramps that largeness of mind which extends to the remotest as well as the nearest interest, and takes in the most durable equally with the most transient gains. It is therefore easy to see how much a man's *credit and reputation*, and consequently his success, depend on his honesty and *virtue*.

With regard to *security and peace* with his neighbours, it may be thought, perhaps, that the man of a quiet forgiving temper, and a flowing benevolence and courtesy, is much exposed to injury and affronts from every proud or peevish mortal, who has the power or will to do mischief. If we suppose, indeed this *quietness and gentleness* of nature accompanied with *cour-*

219  
On one's peace and security.

*dice* and *pufflanimity*, this may often be the case; but in reality the good man is bold as a lion, and so much the bolder for being the calmer. Such a person will hardly be a butt to mankind. The ill-natured will be afraid to provoke him, and the good-natured will not incline to do it. Besides, *true virtue*, which is conducted by reason, and exerted gracefully and without parade, is a most insinuating and commanding thing; if it cannot disarm malice and resentment at once, it will wear them out by degrees, and subdue them at length. How many have, by favours and prudently yielding, triumphed over an enemy, who would have been inflamed into tenfold rage by the fiercest opposition! In fine, *goodness* is the most universally popular thing that can be.

To conclude; the good man may have some enemies, but he will have more friends; and, having given for many marks of private friendship or public virtue, he can hardly be delitute of a patron to protect, or a sanctuary to entertain him, or to protect or entertain his children when he is gone. Though he should have little else to leave them, he bequeaths them the fairest, and generally the most unenvied, inheritance of a *good name*, which, like good seed sown in the field of futurity, will often raise up unsuspected friends, and yield a benevolent harvest of unexpected charities. But should the fragrance of the parent's virtue prove offensive to a perverse or envious age, or even draw persecution on the friendless orphans, there is *one* in heaven who will be more than a father to them, and recompense their parent's virtues by showering down blessings on them.

### CHAP. III.

#### Motives to VIRTUE from the BEING and PROVIDENCE of GOD.

BESIDES the interesting motive mentioned in the *last chapter*, there are two great motives to *virtue*, strictly connected with *human life*, and resulting from the very constitution of the *human mind*. The first is the BEING and PROVIDENCE of GOD; the second is the IMMORTALITY of the SOUL, with *future rewards* and *punishments*.

It appears from Chap. iv. of Part II. that *man*, by the constitution of his nature, is designed to be a RELIGIOUS CREATURE. He is intimately connected with the *Deity*, and necessarily dependent on him. From that connection and necessary dependence result various obligations and duties, without fulfilling which, some of his sublimest powers and affections would be incomplete and abortive. If he be likewise an IMMORTAL creature, and if his *present conduct* shall affect his *future happiness* in another state as well as in the present; it is evident that we take only a *partial view* of the creature if we leave out this important property of his nature, and make a *partial estimate* of *human life*; if we strike out of the account, or overlook, that part of his duration which runs out into eternity.

It is evident from the above-mentioned chapter, that "to have a respect to the *Deity* in our temper and conduct, to venerate and love his character, to adore his goodness, to depend upon and resign ourselves to his providence, to seek his approbation, and act under a sense of his authority, is a fundamental part of

"moral virtue, and the completion of the highest destination of our nature."

But as *piety* is an essential part of virtue, so likewise it is a great support and enforcement to the practice of it. To contemplate and admire a Being of such transcendent dignity and perfection as God, must naturally and necessarily open and enlarge the mind, give a freedom and amplex to its powers, and a grandeur and elevation to its aims. For, as an excellent *divine* observes, "the greatness of an object, and the excellency of the act of any AGENT about a transcendent object, doth mightily tend to the enlargement and improvement of his faculties." Little objects, mean company, mean cares, and mean business, cramp the mind, contract its views, and give it a creeping air and department. But when it soars above mortal cares and mortal pursuits into the regions of divinity, and converses with the greatest and best of Beings, it spreads itself into a wider compass, takes higher flights in reason and goodness, becomes godlike in its air and manners. *Virtue* is, if one may say so, both the effect and cause of largeness of mind. It requires that one think freely, and act nobly. Now what can conduce more to freedom of thought and dignity of action, than to conceive worthily of God, to reverence and adore his unrivalled excellency, to imitate and transcribe that excellency into our own nature, to remember our relation to him, and that we are the image and representatives of his glory to the rest of the creation? Such feelings and exercises must and will make us scorn all actions that are base, unhandsome, or unworthy our state; and the relation we stand in to God will irradiate the mind with the light of wisdom, and ennoble it with the liberty and dominion of virtue.

The influence and efficacy of religion may be considered in another light. We all know that the presence of a friend, a neighbour, or any number of spectators, but especially an august assembly of them, uses to be a considerable check upon the conduct of one who is not lost to all sense of honour and shame, and contributes to restrain many irregular sallies of passion. In the same manner we may imagine, that the awe of some superior mind, who is supposed privy to our secret conduct, and armed with full power to reward or punish it, will impose a restraint on us in such actions as fall not under the controul or animadversion of others. If we go still higher, and suppose our inmost thoughts and darkest designs, as well as our most secret actions, to lie open to the notice of the supreme and universal mind, who is both the spectator and judge of human actions, it is evident that the belief of so august a presence, and such awful inspection, must carry a restraint and weight with it proportioned to the strength of that belief, and be an additional motive to the practice of many duties which would not have been performed without it.

It may be observed farther, that "to live under an habitual sense of the *Deity* and his great administration, is to be conversant with wisdom, order, and beauty, in the highest subjects, and to receive the delightful reflections and benign feelings which these excite while they irradiate upon him from every scene of nature and providence." How improving must such views be to the mind, in dilating and exalt-

210  
On one's family.

211  
Two external motives to virtue.

212  
Their importance.

213  
Piety.

215  
A guard and enforcement to virtue.

Exercises of piety improving to virtue.

ing it above those puny interests and competitions which agitate and inflame the bulk of mankind against each other!

CHAP. IV.

Motive to VIRTUE from the Immortality of the SOUL, &c.

217  
Metaphysical arguments for its immortality.

THE other motive mentioned was the immortality of the soul, with *future rewards and punishments*. The metaphysical proofs of the soul's immortality are commonly drawn from—its *simple, uncompounded, and indivisible nature*; from whence it is concluded, that it cannot be corrupted or extinguished by a dissolution or destruction of its parts:—from its having a *beginning of motion* within itself; whence it is inferred, that it cannot discontinue and lose its motion:—from the different properties of *matter and mind*, the *fugifiveness and inactivity of one*, and the *immense activity of the other*; its prodigious flight of *thought and imagination*; its *penetration, memory, foresight*, and *anticipations of futurity*: from whence it is concluded, that a being of so divine a nature cannot be extinguished. But as these metaphysical proofs depend on intricate reasonings concerning the *nature, properties, and distinctions of body and mind*, with which we are not very well acquainted, they are not obvious to ordinary understandings, and are seldom so convincing even to those of higher reach, as not to leave some doubts behind them. Therefore perhaps it is not so safe to rest the proof of such an important article on what many may call the subtilities of school-learning. Those proofs which are brought from *analogy*, from the *moral constitution and phenomena of the human mind*, the *moral attributes of God*, and the *present course of things*, and which therefore are called the *moral arguments*, are the plainest, and generally the most satisfying. We shall select only one or two from the rest.

218  
Moral proof from analogy.

In tracing the *nature and destination* of any being, we form the surest judgment from his *powers of action*, and the *scope and limits* of these, compared with his *state*, or with that *field* in which they are exercised. If this being passes through different states, or fields of action, and we find a *succession* of powers adapted to the different periods of his progress, we conclude that he was destined for those successive states, and reckon his nature *progressive*. If, besides the immediate set of powers which fit him for action in his present state, we observe another set which appear superfluous if he were to be confined to it, and which point to another or higher one, we naturally conclude, that he is not designed to remain in his present state, but to advance to that for which those supernumerary powers are adapted. Thus we argue, that the *infant*, which has wings forming or formed, and all the apparatus proper for flight, is not destined always to creep on the ground, or to continue in the torpid state of adhering to a wall, but is designed in its season to take its flight in air. Without this farther destination, the admirable mechanism of wings and the other apparatus would be useless and absurd. The same kind of reasoning may be applied to man, while he lives only a sort of *vegetative* life in the womb. He is furnished even there with a beautiful apparatus of organs, eyes, ears, and other delicate senses, which receive nourish-

ment indeed, but are in a manner folded up, and have no proper exercise or use in their present confinement\*. Let us suppose some intelligent spectator, \* *Vide Ludov. Viv. de Relig. Christ. Lib. II. de Vita Utriusq. &c.* who never had any connection with man, nor the least acquaintance with human affairs, to see this odd phenomenon, a creature formed after such a manner, and placed in a situation apparently unfit for such various machinery: must he not be strangely puzzled about the use of his complicated structure, and reckon such a profusion of art and admirable workmanship lost on the subject; or reason by way of anticipation, that a creature endued with such various yet unexercised capacities, was destined for a more enlarged sphere of action, in which those latent capacities shall have full play? The vast variety and yet beautiful symmetry and proportions of the several parts and organs with which the creature is endued, and their apt cohesion with and dependence on the curious receptacle of their life and nourishment, would forbid his concluding the whole to be the birth of chance, or the bungling effort of an unskilful artist; at least would make him demur a while at so harsh a sentence. But if, while he is in this state of uncertainty, we suppose him to see the babe, after a few successful struggles, throwing off his fetters, breaking loose from his little dark prison, and emerging into open day, then unfolding his reclusive and dormant powers, breathing in air, gazing at light, admitting colours, sounds, and all the *fair variety* of nature; immediately his doubts clear up, the propriety and excellency of the workmanship dawn upon him with full lustre, and the whole mystery of the first period is unravelled by the opening of this new scene. Though in this *second* period the creature lives chiefly a kind of *animal-life*, i. e. of *sense and appetite*, yet by various trials and observations he gains experience, and by the gradual evolution of the powers of *imagination* he ripens apace for an *higher* life, for exercising the arts of *design and imitation*, and of those in which strength or dexterity are more requisite than acuteness or reach of judgment. In the succeeding *rational or intellectual* period, his *understanding*, which formerly crept in a lower, mounts into an higher sphere, canvasses the natures, judges of the relations of things, forms schemes, deduces consequences from what is past, and from present as well as past collects future events. By this succession of states, and of correspondent culture, he grows up at length into a *moral, a social, and a political* creature. This is the last period at which we perceive him to arrive in his mortal career. Each *period* is introductory to the next succeeding one; each *life* is a field of exercise and improvement for the next higher one; the life of the *fetus* for that of the *infant*, the life of the *infant* for that of the *child*, and all the lower for the highest and best\*.—But is this the last period of nature's progression? Is this the utmost extent of her plot, where she winds up the drama, and dismisses the actor into eternal oblivion? Or does he appear to be invested with supernumerary powers, which have not full exercise and scope even in the last scene, and reach not that maturity or perfection of which they are capable; and therefore point to some higher scene where he is to sustain another and more important character than he has yet sustained? If any such there are, may we not conclude by analogy, or in the same way of anticipation

\* See Butler's Analogy, Part I.

tion as before, that he is defined for that after-part, and is to be produced upon a more august and solemn stage, where his sublimer powers shall have proportioned action, and its nature attain its completion?

219 Powers in man which point to an after-life.

If we attend to that *curiosity*, or prodigious *thirst of knowledge*, which is natural to the mind in every period of its progress, and consider with the endless round of business and care, and the various hardships to which the bulk of mankind are chained down; it is evident, that in this present state it is impossible to expect the gratification of an appetite at once so insatiable and so noble. Our *senses*, the ordinary organs by which knowledge is let into the mind, are always imperfect, and often fallacious; the advantages of assisting or correcting them are possessed by few; the difficulties of finding out truth amidst the various and contradictory opinions, interests, and passions of mankind, are many; and the wants of the creature, and of those with whom he is connected, numerous and urgent: so that it may be said of most men, that their *intellectual* organs are as much shut up and secluded from proper nourishment and exercise in that little circle to which they are confined, as the bodily organs are in the womb. Nay, those who to an aspiring genius have added all the assistances of art, leisure, and the most liberal education, what narrow prospects can even they take of this unbounded scene of things from that little eminence on which they stand? and how eagerly do they still grasp at new discoveries, without any satisfaction or limit to their ambition?

230 Intellectual.

But should it be said, that man is made for *action*, and not for *speculation*, or fruitless searches after knowledge, we ask, For what kind of action? Is it only for bodily exercises, or for *moral, political, and religious* ones? Of all these he is capable; yet, by the unavoidable circumstances of his lot, he is tied down to the *former*, and has hardly any leisure to think of the *latter*, or, if he has, wants the proper instruments of exerting them. The *love of virtue, of one's friends and country, the generous sympathy with mankind, and heroic zeal of doing good*, which are all so *natural* to great and good minds, and some traces of which are found in the lowest, are seldom united with proportioned means or opportunities of exercising them: so that the *moral* spring, the noble energies and impulses of the mind, can hardly find proper scope even in the most fortunate condition; but are much depressed in some, and almost entirely restrained in the generality, by the numerous clogs of an indigent, sickly, or embarrassed life. Were such mighty powers, such god-like affections, planted in the human breast to be folded up in the narrow womb of our present existence, never to be produced into a more *perfect* life, nor to expatiate in the ample career of immortality?

231 Moral powers.

Let it be considered, at the same time, that no possession, no enjoyment within the round of mortal things, is commensurate to the desires, or adequate to the capacities, of the mind. The most exalted condition has its abatements; the happiest conjuncture of fortune leaves many wishes behind; and, after the highest gratifications, the mind is carried forward in pursuit of new ones without end. Add to all, the fond *desire of immortality*, the secret dread of *non-existence*, and the high unremitting pulse of the soul

232 Unabated desires of existence and happiness.

beating for *perfection*, joined to the improbability or the impossibility of attaining it *here*; and then judge whether this elaborate structure, this magnificent apparatus of inward powers and organs, does not plainly point out a *hereafter*, and *intimate eternity to man*? Does nature give the finishing touches to the lesser and ignobler influences of her skill, and raise every other creature to the maturity and perfection of his being; and shall she leave her principal workmanship unfinished? Does she carry the *vegetative* and *animal* life in *man* to their full vigour and highest destination; and shall she suffer his *intellectual*, his *moral*, his *divine* life to fade away, and be for ever extinguished? Would such abortions in the *moral* world be congruous to that *perfection of wisdom and goodness* which upholds and adorns the *natural*?

We must therefore conclude from this detail, that the *present state*, even at its best, is only the *womb of man's* being, in which the noblest principles of his nature are in a manner fettered, or secluded from a correspondent sphere of action; and therefore destined for a future and unbounded state, where they shall emancipate themselves, and exert the fulness of their strength. The most accomplished mortal, in this low and dark apartment of nature, is only the *rudiments* of what he shall be when he takes his ethereal flight, and puts on immortality. Without a reference to that state, *man* were a mere abortion, a rude unfinished embryo, a monster in nature. But this being once supposed, he still maintains his rank of the masterpiece of the creation; his latent powers are all suitable to the *harmony and progression* of nature; his noble aspirations, and the pains of his dissolution, are his efforts towards a *second birth*, the pangs of his delivery into light, liberty, and perfection; and *death*, his discharge from goal, his separation from his fellow-prisoners, and introduction into the assembly of those heroic spirits who are gone before him, and of their great eternal Parent. The fetters of his mortal coil being loosened, and his prison-walls broke down, he will be bare and open on every side to the admission of *truth and virtue*, and their fair attendant *happiness*; every *vital* and *intellectual* spring will evolve itself with a divine elasticity in the free air of heaven. He will not then peep at the universe and its glorious Author through a dark grate or a gross medium, nor receive the reflections of his glory through the strait openings of sensible organs; but will be *all eyes, all ears, all ethereal and divine feeling*.\* Let one part, however, of the analogy be attended to: That as in the womb we receive our original constitution, form, and the essential *stamina* of our being, which we carry along with us into the light, and which greatly affect the succeeding periods of our life; so our temper and condition in the *future* life will depend on the conduct we have observed, and the character we have formed, in the *present* life. We are *here* in *miniature* what we shall be at *full length hereafter*. The first *rude sketch* or *out-lines of reason and virtue* must be drawn at present, to be afterwards enlarged to the *figure and beauty* of angels.

233 Therefore man immortal.

This, if duly attended to, must prove not only a *guard*, but an admirable *incentive* to virtue. For he who faithfully and ardently follows the lights of knowledge, and pants after higher improvements in virtue, will

234 Immortal guard, and incentive to virtue.

will

\* Vide Religion of Nature, § 9.

will be wonderfully animated and inflamed in that pursuit by a full conviction that the scene does not close with life—that his struggles, arising from the weakness of nature and the strength of habit, will be turned into triumphs—that his career in the tract of wisdom and goodness will be both swifter and smoother—and those generous ardours with which he glows towards heaven, *i. e.* the perfection and immortality of virtue, will find their adequate object and exercise in a sphere proportionably enlarged, incorruptible, immortal. On the other hand, what an inexpressible damp must it be to the good man, to dread the total extinction of that *light and virtue*, without which *life, nay, immortality itself*, were not worth a single wish?

235  
Proof from the inequality of present distributions.

Many writers draw their proofs of the immortality of the soul, and of a future state of rewards and punishments, from the unequal distribution of these here. It cannot be dissembled that wicked men often escape the outward punishment due to their crimes, and do not feel the inward in that measure their demerit seems to require, partly from the callousness induced upon their nature by the habits of vice, and partly from the dissipation of their minds abroad by pleasure or business—and sometimes good men do not reap all the natural and genuine fruits of their virtue, through the many unforeseen or unavoidable calamities in which they are involved. This, no doubt, upon the supposition of an all-wise and good Providence, were an argument, and a strong one too, for a future state, in which those inequalities shall be corrected. But unless we suppose a *preposited good order* in the present scene of things, we weaken the proof of the divine administration, and the presumption of any better order in any future period of it.

236  
Belief of immortality, &c. a great support amidst trials.

Virtue has present rewards, and vice present punishments, annexed to it; such rewards and punishments as make *virtue*, in most cases that happen, far more eligible than *vice*: but, in the infinite variety of human contingencies, it may sometimes fall out, that the inflexible practice of virtue shall deprive a man of considerable advantages to himself, his family, or friends, which he might gain by a well-timed piece of roguery; suppose by betraying his trust, voting against his conscience, selling his country, or any other crime, where the security against discovery shall heighten the temptation. Or, it may happen, that a strict adherence to his honour, to his religion, to the cause of liberty and virtue, shall expose him, or his family, to the loss of every thing, nay, to poverty, slavery, death itself, or to torments far more intolerable. Now what shall secure a man's virtue in circumstances of such trial? What shall enforce the obligations of conscience against the allurements of so many interests, the dread of so many and so terrible evils, and the almost insurmountable aversion of human nature to excessive pain! The conflict is the greater, when the circumstances of the crime are such as easily admit a variety of alleviations from necessity, natural affection, love to one's family or friends, perhaps in indigence: these will give it even the air of virtue. Add to all, that the crime may be thought to have few bad consequences,—may be easily concealed,—or imagined possible to be retrieved in a good measure by future good conduct. It is obvious to which side most men will lean in such a case; and how much need there is of a balance in the opposite scale, from the considera-

tion of a God, of a Providence, and of an *immortal state of retribution*, to keep the mind firm and uncorrupt in those or like instances of singular trial or distress.

But without supposing such peculiar instances, a sense of a governing Mind, and a persuasion that virtue is not only benefitted by him here, but will be rewarded by him hereafter with rewards suitable to its nature, vast in themselves, and immortal in their duration, must be not only a mighty support and incentive to the practice of virtue, but a strong barrier against vice. The thoughts of an Almighty Judge, and of an impartial future reckoning, are often alarming, inexpressible so, even to the stoutest offenders. On the other hand, how supporting must it be to the good man, to think that he acts under the eye of his friend, as well as judge! How improving, to consider the *present state* as connected with a *future one*, and every relation in which he stands as a *school of discipline for his affections*; every trial as the exercise of some virtue; and the virtuous deeds which result from both, as introductory to higher scenes of *action and enjoyment*! Finally, how transporting is it to view death as his discharge from the warfare of mortality, and a triumphant entry into a state of freedom, security, and perfection, in which knowledge and wisdom shall break upon him from every quarter; where each faculty shall have its proper object; and his virtue, which was often damped or defeated here, shall be enthroned in undisturbed and eternal empire!

On reviewing this short *system of morals*, and the motives which support and enforce it, and comparing of the both with the *CHRISTIAN scheme*, what light and vigour do they borrow from thence! How clearly and fully does *CHRISTIANITY* lay open the connections of our nature, both *material and immaterial*, and *future as well as present*! What an ample and beautiful detail does it present of the duties we owe to God, to society, and ourselves, promulgated in the most simple, intelligible, and popular manner; divested of every partiality of sect or nation; and adapted to the general state of mankind! With what bright and alluring examples does it illustrate and recommend the practice of those duties; and with what mighty sanctions does it enforce that practice! How strongly does it describe the corruptions of our nature; the deviations of our life from the rule of duty, and the causes of both! How marvellous and benevolent a plan of redemption does it unfold, by which those corruptions may be remedied, and our nature restored from its deviations to transcendent heights of *virtue and piety*! Finally, what a fair and comprehensive prospect does it give us of the administration of God, of which it represents the *present state* only as a *small period*, and a *period of warfare and trial*! How solemn and unbounded are the scenes which it opens beyond it! the resurrection of the dead, the general judgment, the equal distribution of rewards and punishments to the good and the bad; and the full completion of divine wisdom and goodness in the final establishment of order, perfection, and happiness! How glorious then is that SCHEME of RELIGION, and how worthy of affection as well as of admiration, which, by making such discoveries, and affording such assistances, has disclosed the un fading fruits and triumphs of VIRTUE, and secured its interests beyond the power of TIME and CHANCE!



Moral

Moravia.

Moravia.

*MORAL Sense*, that whereby we perceive what is good, virtuous, and beautiful, in actions, manners, and characters. See *MORAL Philosophy*.

*MORALITY*. See *MORAL Philosophy*.

*MORASS*, a low and moist land, which receives the waters from the higher grounds without having any descent to carry them off.

*MORATA* (*Olympia Fulvia*), an Italian lady, distinguished for her learning, was born at Ferrara, in 1526. Her father, after teaching the belles lettres in several cities of Italy, was made preceptor to the two young princes of Ferrara, the sons of Alphonius I. The uncommon abilities he discovered in his daughter determined him to give her a very extraordinary education. Meanwhile the prince of Ferrara studying polite literature, it was judged expedient that she should have a companion in the same pursuit; and *Morata* being called, she was heard by the astonished courtiers to declaim in Latin, to speak Greek, and to explain the paradoxes of Cicero. Her father dying, she was obliged to return home, to take upon her the management of family-affairs, and the education of her brother and three sisters; both which she executed with the greatest diligence and success. In the mean time Andrew Grunthler, a young German, who had studied physic, and taken his doctor's degree at Ferrara, fell in love with her, and married her. She now went with her husband to Germany, taking her little brother with her, whom she instructed in the Latin and Greek tongues; and after staying a short time at Augsburg, went to Schweinfurt in Franconia, where her husband was born: but they had not been there long before that town was unhappily besieged and burnt; however, escaping the flames, they fled in the utmost distress to Hamelburg. This place they were also obliged to quit, and were reduced to the last extremities, when the elector palatine invited Grunthler to be professor of physic at Heidelberg, and he entered on his new office in 1554; but they no sooner began to taste the sweets of repose, than a disease, occasioned by the distresses and hardships they had suffered, seized upon *Morata*, who died in 1555, in the 29th year of her age; and her husband and brother did not long survive her. She composed several works, great part of which were burnt with the town of Schweinfurt; the remainder, which consist of orations, dialogues, letters, and translations, were collected and published under the title of *Olympie Fulvie Morate, fœmine doctissime, et plane divine, opera omnia quæ hactenus invenire poterunt; quibus Cœli secundæ curionis epistola ac orationes accesserunt*; which has had several editions in octavo.

*MORAVIA*, a marquise of Germany, derives the name of *Mahern*, as it is called by the Germans, and of *Morawa*, as it is called by the natives, from the river of that name which rises in the mountains of the county of Glatz, and passes through the middle of it. It is bounded to the south by Austria, to the north by Glatz and Silesia, to the west by Bohemia, and to the east by Silesia and Hungary; being about 120 miles in length, and 100 in breadth.

A great part of this country is over-run with woods and mountains, where the air is very cold, but much wholesomer than in the low grounds, which are full of bogs and lakes. The mountains, in general, are

barren; but the more champaign parts tolerably fertile, yielding corn, with plenty of hemp and flax, good saffron, and pasture. Nor is it altogether destitute of wine, red and white, fruits, and garden-stuff. *Moravia* also abounds in horses, black cattle, sheep, and goats. In the woods and about the lakes there is plenty of wild fowl, game, venison, bees, honey, hares, foxes, wolves, hawks, &c. In this country are likewise quarries of marble, bastard diamonds, amethysts, alum, iron, sulphur, salt-petre, and vitriol, with wholesome mineral-waters, and warm springs; but salt is imported. Its rivers, of which the March, *Morawa*, or *Morau*, are the chief, abound with trout, crayfish, barbels, eels, perch, and many other sorts of fish.

The language of the inhabitants is a dialect of the Sclavonic, differing little from the Bohemian; but the nobility and citizens speak German and French.

*Moravia* was anciently inhabited by the *Quadi*, who were driven out by the *Slavi*. Its kings, who were once powerful and independent, afterwards became dependent on, and tributary to, the German emperors and kings. At last, in the year 908, the *Moravian* kingdom was parcelled out among the Germans, Poles, and Hungarians. In 1086, that part of it properly called *Moravia* was declared a marquise by the German king Henry IV. and united with Bohemia, to whose dukes and kings it hath ever since been subject. Though it is not very populous, it contains about 42 greater or walled towns, 17 smaller or open towns, and 198 market-towns, besides villages, &c. The states of the country consist of the clergy, lords, knights, and burgeses; and the diets, when summoned by the regency, are held at Brunn. The marquise is still governed by its own peculiar constitutions, under the *directorium in publicis & camerariis*, and the supreme judicatory at Vienna. It is divided into six circles, each of which has its captain, and contributes to its sovereign about one-third of what is exacted of Bohemia. Towards the expences of the military establishment of the whole Austrian hereditary countries, its yearly quota is 1,856,490 florins. Seven regiments of foot, one of cuirassiers, and one of dragons, are usually quartered in it.

Christianity was planted in this country in the 9th century; and the inhabitants continued attached to the church of Rome till the 15th, when they espoused the doctrine of John Huss, and threw off popery: but after the defeat of the elector Palatine, whom they had chosen king, as well as the Bohemians, the emperor Ferdinand II. re-established popery. However, there are still some Protestants in *Moravia*; and here it was that the *Herrnhuters*, or *Moravian Brethren*, first made their appearance. See *MORAVIANS*. The bishop of Olmutz, who stands immediately under the pope, is at the head of the ecclesiastics in this country. The supreme ecclesiastical jurisdiction, under the bishop, is vested in a consistory.

The commerce of this country is inconsiderable. Of what they have, Brunn enjoys the principal part. At Iglau and Trebitz are manufactures of cloth, paper, gun-powder, &c. There are also some iron-works and glass-houses in the country.

The inhabitants of *Moravia* in general are open-hearted, not easy to be provoked or pacified, obedient to their masters, and true to their promises; but credu-

lous.

Moravians  
Mordaunt.

lous of old prophecies, and much addicted to drinking, though neither such fots or bigots as they are represented by some geographers. The boors, indeed, upon the river Hanak, are said to be a thievish, unpolished, brutal race. The sciences now begin to lift up their heads a little among the Moravians, the univerſity of Olmutz having been put on a better footing; and a riding academy, with a learned ſociety, have been lately eſtabliſhed there.

MORAVIANS, a ſect of Proteſtants, who have been ſettled for a conſiderable time paſt at Hernuth in Moravia, and have of late years ſpread themſelves over moſt of our American colonies, as well as in ſeveral parts of England, where they are permitted to ſettle, by a late act of parliament. They have a kind of church-government peculiar to themſelves; and are commonly known by the name of *Unitas Fratrum*, or *The Brethren*. They profeſs the utmoſt veneration for our bleſſed Saviour, whom they conſider as their immediate head and director; enjoin the moſt implicit obedience to the rulers of their church; and are ſaid to praſtiſe much brotherly love amongſt one another; but from many of their tenets, it would appear, that obſcenity makes no ſmall part of their devotion. See ZINZENDORFF.

MORBID, among phyſicians, ſignifies “difeaſed or corrupt;” a term applied either to an unſound conſtitution, or to thoſe parts or humours that are affected by a diſeaſe.

MORBUS SACER, in medicine, the ſame with HERANOSOS. See MEDICINE, p. 4787. col. 2.

MORBUS Regius, the ſame with the JAUNDICE. See MEDICINE, n<sup>o</sup> 453.

MORBUS, or *Diſcaſe*, in botany. See VARIETAS.

MORDAUNT (Charles), earl of Peterborough, a celebrated commander both by ſea and land, was the ſon of John Lord Mordaunt, viſcount Avalon, and was born about the year 1658. In 1675 he ſucceeded his father in his honours and eſtate. While young he ſerved under the admirals Torrington and Narborough in the Mediterranean, againſt the Algerines; and in 1680 embarked for Africa with the earl of Plymouth, and diſtinguiſhed himſelf at Tangier when it was beſieged by the Moors.

In the reign of James II. he voted againſt the repeal of the teſt-act; and diſliking the meaſures of the court, obtained leave to go to Holland to accept the command of a Dutch ſquadron in the Weſt Indies. He afterwards accompanied the prince of Orange into this kingdom; and upon his advancement to the throne, was ſworn of the privy-council, made one of the lords of the bedchamber to his majeſty, alſo firſt commiſſioner of the treaſury, and advanced to the dignity of earl of Monmouth. But, in November 1690, he was diſmiſſed from his poſt in the treaſury. On the death of his uncle Henry earl of Peterborough in 1697, he ſucceeded to that title; and, upon the acceſſion of queen Anne, was inveſted with the commiſſion of captain-general and governor of Jamaica. In 1705 he was ſworn of the privy-council; and the ſame year declared general and commander in chief of the forces ſent to Spain, and joint admiral of the fleet with Sir Cloudſley Shovel, of which the year following he had the ſole command. His taking Barcelona with a handful of men, and afterwards relieving it when greatly di-

Mordaunt  
More.

ſtreſſed by the enemy; his driving out of Spain the duke of Anjou, and the French army, which conſiſted of 25,000 men, though his own troops never amounted to 10,000; his gaining poſſeſſion of Catalonia, of the kingdoms of Valencia, Arragon, and the iſle of Majorca, with part of Murcia and Caſtile, and thereby giving the earl of Galway an opportunity of advancing to Madrid without a blow; are aſtoniſhing inſtances of his bravery and conduct. For theſe important ſervices his Lordſhip was declared general in Spain by Charles III. England's emperor of Germany; and on his return to England he received the thanks of the Houſe of Lords. His Lordſhip was afterwards employed in ſeveral embaſſies to foreign courts, inſtalled knight of the garter, and made governor of Minorca. In the reign of George I. he was general of all the marine forces in Great Britain, in which poſt he was continued by king George II. He died in his paſſage to Liſbon, where he was going for the recovery of his health, in 1735.

His Lordſhip was diſtinguiſhed by his poſſeſſing various ſhining qualities: for, to the greateſt perſonal courage and reſolution, he added all the arts and addreſs of a general; a lively and penetrating genius; and a great extent of knowledge upon almoſt every ſubject of importance within the compaſs of ancient and modern literature; hence his familiar letters, inſerted among thoſe of his friend Mr Pope, are an ornament to that excellent collection.

MORDELLA, in zoology, a genus of the coleoptera claſs of inſects. The antennæ are thread-shaped and ferrated; the head is deſtroyed under the neck; the pappi are clavated, compressed, and obliquely blunt-ed; and the elytra are bent backwards near the apex. There are fix ſpecies, all natives of different parts of Europe.

MORE (Sir Thomas), lord high chancellor of England, the ſon of Sir John More, knight, one of the judges of the king's-bench, was born in the year 1480, in Milk-ſtreet, London. He was firſt ſent to a ſchool at St Anthony's in Threadneedle-ſtreet; and afterwards introduced into the family of cardinal Moreton, who, in 1497, ſent him to Canterbury college in Oxford. During his reſidence at the univerſity he conſtantly attended the lectures of Linacre and Grocinius, on the Greek and Latin languages. Having in the ſpace of about two years made conſiderable proficiency in academical learning, he came to New-inn in London, in order to ſtudy the law; whence, after ſome time, he removed to Lincoln's-inn, of which his father was a member. Notwithſtanding his application to the law, however, being now about 20 years old, he was ſo bigotted to monkish diſcipline, that he wore a hair-ſhirt next his ſkin, frequently faſted, and often ſlept on a bare plank. In the year 1503, being then a burgeſs in parliament, he diſtinguiſhed himſelf in the houſe, in oppoſition to the motion for granting a ſubſidy and three fifteenths for the marriage of Hen. VII.'s eldeſt daughter, Margaret, to the king of Scotland. The motion was rejected; and the king was ſo highly offended at this oppoſition from a beardless boy, that he revenged himſelf on Mr More's father, by ſending him on a frivolous pretence to the Tower, and obliging him to pay 100l. for his liberty. Being now called to the bar, he was appointed law-reader at Furnival's

val's inn, which place he held about three years; but about this time, he also read a public lecture in the church of St Lawrence, Old Jewry, upon St Austin's treatise *De civitate Dei*, with great applause. He had indeed formed a design of becoming a Franciscan friar, but was dissuaded from it; and, by the advice of Dr Colet, married Jane, the eldest daughter of John Colt, Esq; of Newhall in Essex. In 1508 he was appointed judge of the sheriff's court in the city of London, was made a justice of the peace, and became very eminent at the bar. In 1516 he went to Flanders in the retinue of bishop Tonilal and Dr Knight, who were sent by king Henry VIII. to renew the alliance with the archduke of Austria, afterwards Charles V. On his return, cardinal Wolsey would have engaged Mr More in the service of the crown, and offered him a pension, which he refused. Nevertheless, it was not long before he accepted the place of master of the requests, was created a knight, admitted of the privy-council, and in 1520 made treasurer of the exchequer. About this time he built a house on the bank of the Thames, at Chelsea, and married a second wife. This wife, whose name was *Middleton*, and a widow, was old, ill-tempered, and covetous; nevertheless Erasmus says he was as fond of her as if she were a young maid.

In the 14th year of Henry VIII. Sir Thomas More was made speaker of the house of commons: in which capacity he had the resolution to oppose the then powerful minister, Wolsey, in his demand of an oppressive subsidy; notwithstanding which, it was not long before he was made chancellor of the duchy of Lancaster, and was treated by the king with singular familiarity. The king having once dined with Sir Thomas at Chelsea, walked with him near an hour in the garden, with his arm round his neck. After he was gone, Mr Roper, Sir Thomas's son-in-law, observed how happy he was to be so familiarly treated by the king; to which Sir Thomas replied, "I thank our lord, son Roper, I find his grace my very good lord indeed, and believe he doth as singularly favour me as any subject within this realm: howbeit, I must tell thee, I have no cause to be proud thereof; for, if my head would win him a castle in France, it would not fail to go off." From this anecdote it appears, that Sir Thomas knew his grace to be a villain.

In 1526 he was sent, with cardinal Wolsey and others, on a joint embassy to France, and in 1529 with bishop Tonilal to Cambray. The king, it seems, was so well satisfied with his services on these occasions, that in the following year, Wolsey being disgraced, he made him chancellor; which seems the more extraordinary, when we are told that Sir Thomas had repeatedly declared his disapprobation of the king's divorce, on which the great *defensor fidei* was so positively bent. Having executed the office of chancellor about three years, with equal wisdom and integrity, he resigned the seals in 1533, probably to avoid the danger of his refusing to confirm the king's divorce. He now retired to his house at Chelsea; dif-

missed many of his servants; sent his children with their respective families to their own houses, (for hitherto he had, it seems, maintained all his children, with their families, in his own house, in the true style of an ancient patriarch); and spent his time in study and devotion; but the capricious tyrant would not suffer him to enjoy this tranquillity. Though now reduced to a private station, and even to indigence, his opinion of the legality of the king's marriage with Anne Boleyn, was deemed of so much importance, that various means were tried to procure his approbation; but all persuasion proving ineffectual, he was, with some others, attainted in the house of lords of misprision of treason, for encouraging Eliz. Barton, the nun of Kent, in her treasonable practices. His innocence in this affair appeared so clearly, that they were obliged to strike his name out of the bill. He was then accused of other crimes, but with the same effect; till, refusing to take the oath enjoined by the act of supremacy, he was committed to the Tower, and, after 15 months imprisonment, was tried at the bar of the king's-bench, for high treason, in denying the king's supremacy. The proof rested on the sole evidence of Rich the solicitor-general, whom Sir Thomas, in his defence, sufficiently discredited: nevertheless the jury brought him in guilty, and he was condemned to suffer as a traitor. The merciful Harry however indulged him with simple decollation; and he was accordingly beheaded on Tower-hill, on the 5th of July 1535. His body, which was first interred in the Tower, was begged by his daughter Margaret, and deposited in the chancel of the church at Chelsea, where a monument, with an inscription written by himself, had been some time before erected. This monument with the inscription is still to be seen in that church. The same daughter, Margaret, also procured his head after it had remained 14 days upon London-bridge, and placed it in a vault belonging to the Roper's family, under a chapel adjoining to St Dunstan's church in Canterbury. Sir Thomas More was a man of some learning, and an upright judge; a very priest in religion, yet cheerful, and even affectedly witty (A). He wanted not sagacity, where religion was out of the question; but in that his faculties were so enveloped, as to render him a weak and credulous enthusiast. He left one son and three daughters; Margaret, the eldest of which, was very remarkable for her knowledge of the Greek and Latin languages. She married a Mr Roper of Well-hall in Kent, whose Life of Sir Thomas More was published by Mr Hearne at Oxford, in 1716. Mrs Roper died in 1544; and was buried in the vault of St Dunstan's in Canterbury, with her father's head in her arms.

Sir Thomas was the author of various works, tho' his *Utopia* is the only performance that has survived in the esteem of the world; owing to the rest being chiefly of a polemic nature: his answer to Luther has only gained him the credit of having the best knack of any man in Europe, at calling bad names in good Latin.

(A) This last disposition, we are told, he could not refrain even at his execution. The day being come, he ascended the scaffold, which seemed so weak, that it was ready to fall; whereupon, "I pray (said he) see me safe up, and for my coming down let me flit for myself." His prayers being ended, he turned to the executioner, and with a cheerful countenance said, "Pluck up thy spirits, man, and be not afraid to do thy office; my neck is very short, take heed therefore thou strike not awry for saving thy honesty." Then laying his head upon the block, he bid him stay until he had put aside his beard, saying, "That had never committed any treason."

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 Morel.

His English works were collected and published by order of queen Mary, in 1557; his Latin, at Basil in 1563, and at Louvain in 1566.

MORE (Henry), an eminent English divine and philosopher, in the 17th century, was educated at Eton school, and in Christ-college in Cambridge, of which he became a fellow, and spent his life in a retired way, publishing a great number of excellent works. He refused bishoprics both in Ireland and England. He was an open-hearted, sincere Christian philosopher, who studied to establish men in the belief of providence against atheism. Mr Hobbes was used to say, that if his own philosophy was not true, there was none that he should sooner like than our philosopher's. His writings have been published together in Latin and English, folio.

MOREA, formerly called the *Peloponnesus*, is a peninsula to the south of Greece, to which it is joined by the isthmus of Corinth. Its form resembles a mulberry-leaf, and its name is derived from the great number of mulberry-trees which grow there. It is about 180 miles in length, and 130 in breadth. The air is temperate, and the land fertile, except in the middle, where it is full of mountains, and is watered by a great number of rivers. It is divided into three provinces; Scania, Belvedera, and Brazzo-di-Maina. It was taken from the Turks by the Venetians in 1687; but they lost it again in 1715. The fangia of the Morea resides at Modon. See GREECE and PELOPONNESUS.

MOREAU (James), an eminent French physician, born at Chalons-sur-Saone, was the disciple and friend of the famous Cuy Patin. He drew upon himself the jealousy and hatred of the old physicians by the public theses he maintained, and afterwards vindicated in his writings. He died in a very advanced age, in 1729. He wrote in French, 1. Consultations on the Rheumatism. 2. A chemical treatise on Fevers. 3. A physical dissertation on the Dropsy; and other works which are esteemed.

MOREL, the name of several celebrated printers to the kings of France, who, like the STEPHENS's, were also men of great learning. William Morel died at Paris in 1564. Frederic Morel, who was also interpreter in the Greek and Latin tongues, as well as printer to the king, died in 1583. He left a son of his own name, who became more famous than his father; and who had so strong an attachment to study, that when he was informed of his wife's being at the point of death he would not lay down his pen till he had finished what he was upon; and when she was dead, as she was before they could prevail upon him to stir, he was only heard to reply coldly; "I am very sorry; she was a good woman." This Frederic Morel died in June 1630, aged 38 years, after having printed a great number of authors in such a manner as shew him to have been a very learned and ingenious man. His sons and grandsons trode in his steps; they distinguished themselves in literature, and maintained also the reputation which he had acquired by printing.

MOREL (Andreas), a very eminent antiquary, born at Berne in Switzerland. Having a strong passion for the study of medals, he travelled through several countries, and made large collections: in 1683 he published at Paris in 8vo, *Specimen universa rei nummarie antiquae*; and the great work of which this was the

specimen, was to be a complete collection of all ancient medals, of which he had at that time 20,000 exactly designed. Soon after this essay appeared, Lewis XIV. gave him a place in his cabinet of antiques, in which capacity he brought himself into great danger by speaking too freely of M. Louvois on account of the neglect in paying his salary, or on some other private account; as he was committed to the Bastille, where he lay for three years: nor was he released until the death of Louvois, nor till the canton of Berne had interceded in his favour. He afterward accepted an invitation from the count of Schwartzburg at Arnstadt in Germany, with whom he lived in the capacity of antiquary, and was furnished with every thing necessary for carrying on his grand work. In 1703 he died; and in 1734 came out at Amsterdam part of this collection, in 2 vols folio, under the title of *Theaurus Morellianus, sive familiarum Romanorum numismata omnia, diligentissime undique conquesta, &c. Nunc primum editis & commentario perpetuo illustravit Sigbertus Havercampus*. These volumes contain an explication of 3539 medals, engraved, with their reverses.

MORENA, (anc. geog.), a district or division of Mysia, in the Hither Asia. A part of which was occupied by Cleon, formerly at the head of a band of robbers; but afterwards priest of Jupiter Abrettenus, and enriched with possessions, first by Antony, and then by Cæsar.

MORRERI (Lewis), author of the Historical Dictionary, was born at Bargemont in Provence 1643. He learned rhetoric and philosophy at Aix, and divinity at Lyons. At 18 years of age he wrote a small piece, intitled *Le Pays d'Amour*; and a collection of the finest French poems, intitled *Deux plaisirs de la Poësie*. He learned Spanish and Italian; and translated out of Spanish into French, the book intitled *La Perfection Chretienne de Rodriguez*. He then refined the Saints Lives to the purity of the French tongue. Being ordained priest, he preached at Lyons; and undertook, when he was but 30 years of age, a new Historical Dictionary, printed at Lyons in one vol. folio, 1673. But his continual labour impaired his health; so that he died in 1680, aged 37. His second volume was published after his death; and four more volumes have since been added. He left some other works behind him.

MORESCK, or MORISCO, is a kind of painting, carving, &c. done after the manner of the Moors; consisting of several grotesque pieces and compartments, promiscuously mingled, not containing any perfect figure of a man, or other animal; but a wild resemblance of birds, beasts, trees, &c.

MORGAGNI (John Baptist), doctor of medicine, first professor of anatomy in the university of Padua, and member of several of the most eminent societies of learned men in Europe, was born in the year 1682, at Forli, a town in the district of *La Romagna* in Italy. His parents, who were in easy circumstances, allowed him to follow that course in life his genius dictated. He began his studies at the place of his nativity; but soon after removed to Bologna, where he obtained the degree of Doctor of Medicine, when he had but just reached the 16th year of his age. Here his peculiar taste for anatomy found an able preceptor in Valsalva, who bestowed on him the utmost attention; and, such was the

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Morgagni. the progress he made under this excellent master, that at the age of 20 he himself taught anatomy with high reputation. Soon, however, the fame of his prelections, and the number of his pupils, excited the jealousy of the public professors, and gave rise to invidious persecutions. But his abilities and prudence gained him a complete triumph over his enemies; and all opposition to him was finally terminated from his being appointed by the senate of Bologna to fill a medical chair, which soon became vacant. But the duties of this office, although important, neither occupied the whole of his time, nor satisfied his anxious desire to afford instruction. He still continued to labour in secret on his favourite subject, and soon after communicated the fruits of these labours to the public in his *Adversaria Anatomica*, the first of which was published in the year 1706, the second and third in 1717, and the three others in 1719. The publication of this excellent work spread the fame of Morgagni far beyond the limits of the state of Bologna. Such was his reputation, that the wise republic of Venice had no hesitation in making him an offer of the second chair of the theory of medicine in the university of Padua, then vacant by the death of Mr Molinetti; and, to ensure his acceptance, they doubled the emoluments of that appointment. While he was in this department, he published his treatise, entitled *Nova institutionum medicarum idea*, which first appeared at Padua in the year 1712. From this work his former reputation suffered no diminution. And soon after he rose, by different steps, to be first professor of anatomy in that celebrated university. Although Morgagni was thus finally settled at Padua, yet he gave evident proofs of his gratitude and attachment to Bologna, which he considered as his native country with respect to the sciences. He exerted his utmost efforts in establishing the academy of Bologna, of which he was one of the first associates; and he enriched their publications with several valuable and curious papers. Soon after this, the royal societies of London and Paris received him among their number. Not long after the publication of his *Adversaria Anatomica*, he began, much upon the same plan, his *Epistole Anatomice*, the first of which is dated at Padua in the beginning of April 1726. The works of Morgagni which have already been mentioned, are to be considered, in a great measure, as strictly anatomical; but he was not more eminent as an anatomist, than as a learned and successful physician. In the year 1760, when he was not far distant from the 80th year of his age, he published his large and valuable work *De causis et sedibus morborum per anatomen indagatis*. This last and most important of all his productions will afford convincing evidence of his industry and abilities to latest posterity. Besides these works, he published, at different periods of his life, several miscellaneous pieces, which were afterwards collected into one volume, and printed under his own eye at Padua, in the year 1765. It does not appear that he had in view any future publications; but he intended to have favoured the world with a complete edition of all his works, which would probably have been augmented with many new observations. In this he was engaged, when, on the 5th of December 1771, after he had nearly arrived at the 90th year of his age, death put a period to his long and glori-

ous career in the learned world.

MORHOFF (Daniel George), a very learned German, born at Wismar in the duchy of Mecklenburgh, in 1639. The duke of Holstein, when he founded an university at Kiel, made him professor of eloquence and poetry there in 1665; to which was afterwards added the professorship of history, and in 1680 the office of librarian to the university. He was the author of many works of a small kind; as orations, dissertations, theses, and poems: but his chief work was his *Polyhistor, sive de notitia auctorum & rerum commentarii*; first published at Lubec in 1688; which has been greatly enlarged since his death in 1691, and gone through several successive editions.

MORIAH, one of the eminences of Jerusalem; on which Abraham went to offer his son, and David wanted to build the temple, which was afterwards executed by Solomon: The threshing-floor of Araunah; originally narrow, so as scarce to contain the temple, but enlarged by means of ramparts; and surrounded with a triple wall, so as to add great strength to the temple, (Josephus). It may be considered as a part of Mount Sion, to which it was joined by a bridge and gallery, (*Id.*)

MORIN (John Baptist), physician and regius professor of mathematics at Paris, was born at Villefranche in Beauvois, in 1583. After commencing doctor at Avignon, he went to Paris, and lived with Claude Dormi bishop of Boulogne, who sent him to examine the mines of Hungary; and thereby gave occasion to his *Mundus subterraneus anatomia*, which was his first production, and published in 1619. Upon his return to his patron the bishop, he contracted an attachment to judicial astrology, concerning which he furnished the world with many ridiculous stories, and wrote a great number of books not worth enumerating. He died in 1656, before he had finished the favourite labour of life, which was his *Astrologia Gallica*. Louisa Maria de Gonzaga queen of Poland gave 2000 crowns to carry on the edition, at the recommendation of one of her secretaries, who was a lover of astrology; and it appeared at the Hague in 1661, in one vol. folio, with two dedications, one to Jesus Christ, and another to the queen of Poland.

MORIN (John), a very learned Frenchman, born at Blois, of Protestant parents, in 1591; but converted by cardinal du Perron to the catholic religion. He published, in 1626, some Exercitations upon the original of patriarchs and primates, and the ancient usage of ecclesiastical censures; dedicated to pope Urban VIII. In 1628 he undertook the edition of the Septuagint Bible, with Nobilius's version; and placed a preface before it, in which he treats of the authority of the Septuagint, and prefers the version in the edition made at Rome by order of Sixtus V. to the present Hebrew text, which he affirms has been corrupted by the Jews. About the same time he gave a French history of the deliverance of the church by the emperor Constantine; and of the temporal greatness conferred on the Roman church by the kings of France. He afterwards published Exercitations upon the Samaritan Pentateuch; and took the care of the Samaritan Pentateuch, for the Polyglot then preparing at Paris. He was greatly cared for at Rome; where, after living nine years, at the invitation of cardinal Bar-

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barini, he was recalled by cardinal Richlieu, and died at Paris in 1659. His works are very numerous; and some of them as much valued by Protestants as Papists for the oriental learning they contain.

MORINUS (Stephen), a learned French Protestant, born at Caen in 1625. He became minister of two churches near Caen, and in 1664 was chosen minister of Caen; but on the revocation of the edict of Nantz, was obliged to take refuge in Holland. He was soon called to be professor of the oriental tongues at Amsterdam, to which employment was afterwards joined that of minister in ordinary: he died in 1700. He was the author of several works: and his fondness for the Hebrew language made him run into some extravagancies concerning it; for in his *Lettre sur l'origine de la langue Hebraïque*, he endeavours to prove that language as old as the creation, and that God himself inspired it into Adam. This was answered by Huet.

MORISON (Robert), physician and professor of botany at Oxford, was born at Aberdeen in 1620, bred at the university there, and taught philosophy for some time in it; but having a strong inclination to botany, made great progress in it. The civil wars obliged him to leave his country; which, however, he did not do till he had first signalized his zeal for the interest of the king, and his courage, in a battle fought between the inhabitants of Aberdeen and the Presbyterian troops on the bridge of Aberdeen, in which he received a dangerous wound on the head. As soon as he was cured of it, he went into France; and fixing at Paris, he applied assiduously to botany and anatomy. He was introduced to the duke of Orleans, who gave him the direction of the royal gardens at Blois. He exercised the office till the death of that prince, and afterwards went over to England in 1660. Charles II. to whom the duke of Orleans had presented him at Blois, sent for him to London, and gave him the title of his physician, and that of professor royal of botany, with a pension of 200*l.* per annum. The *Prælium Botanicum*, which he published in 1669, procured him so much reputation, that the university of Oxford invited him to the professorship of botany in 1669; which he accepted, and acquitted himself in it with great ability. He died at London in 1683, aged 63. He published a second and third part of his *History of Plants*, in 2 vols, folio; with this title *Plantarum Historiæ Oxoniensis Universalis*. The first part of this excellent work has not been printed; and it is not known what has become of it.

MORLACHIA, a mountainous country of Dalmatia. The inhabitants are called *Morlacchi* or *Morlacchi*; and inhabit the pleasant valleys of Koter, along the rivers Kerha, Cettina, Narenta, and among the inland mountains of Dalmatia. The inhabitants are by some said to be of Walachian extraction, as (according to these authors), is indicated even by their name; Morlachia being a contraction of *Mauro-Walachia*, that is, *black Walachia*: and the Walachians are said to be descendants of the ancient Roman colonies planted in these countries. This however is denied by the abbe Fortis, who hath published a volume of travels into that country. He informs us, that the origin of the Morlacchi is involved in the darkness of barbarous ages, together with that of many other nations, resembling them so much in customs and

language, that they may be taken for one people, *Morslachia*. dispersed in the vast tracks from the Adriatic sea to the frozen ocean. The emigrations of the various tribes of the Slavi, who, under the names of *Scythians, Giti, Goths, Hunni, Slavini, Croats, Avari, and Vandals*, invaded the Roman empire, and particularly the Illyrian provinces during the decline of the empire, must have strangely perplexed the genealogies of the nations which inhabited it, and which perhaps removed thither in the same manner as at more remote periods of time. The remainder of the Ardæi, Autariæ, and other Illyrian people anciently settled in Dalmatia, who probably could not reconcile themselves to a dependence on the Romans, might nevertheless naturally enough form an union with foreign invaders not unlike themselves in dialect and customs; and, according to our author, it seems no ill-founded conjecture, that many families, driven out of Hungary by the irruption of the Moguls under Jenghiz Khan and his successors, might people the deserted valleys between the mountains of Dalmatia. This conjecture is also somewhat confirmed by the traces of the Calmuck Tartars, which are still to be found in a part of that country called *Zara*.

With regard to the etymology of the name, the abbe observes, that the Morlacchi generally call themselves, in their own language, *Vlassi*; a national term, of which no vestige is found in the records of Dalmatia till the 13th century. It signifies *powerful men*, or *men of authority*, and the denomination *Moro-Vlassi*, corruptly *Morlacchi*, as they are now called, may perhaps point out the original of the nation. This word may possibly signify the conquerors that came from the sea; *Moor*, in all the dialects of the Slavonian language, signifying the sea.

The Morlacchi are so different from the inhabitants of the sea-coasts in dialect, dress, dispositions, and customs, that they seem clearly to be of a different original, or at least the colonies must have settled at such distant periods from each other, that they have had time to alter in a great measure their national character. There is also a remarkable diversity among the Morlacchi themselves in several districts, probably on account of the different countries from whence they came.

With regard to the character of these people, we are informed that they are much injured by their maritime neighbours. The inhabitants of the sea-coast of Dalmatia tell many frightful stories of their avarice and cruelty: but these, in our author's opinion, are all either of an ancient date; or if any have happened in latter times, they ought rather to be ascribed to the corruption of a few individuals, than to the bad disposition of the nation in general; and though thievish tricks are frequent among them, he informs us, that a stranger may travel securely through their country, where he is faithfully escorted, and hospitably treated. The greatest danger is from the *Haiduki* or *Banditti*, of whom there are great numbers among the woods and caves of these dreadful mountains on the confines. There, says our author, a man ought to get himself escorted by a couple of these "honest fellows;" for they are not capable of betraying him, although a banditti; and their situation is commonly more apt to raise compassion than diffidence. They lead their life  
among

Morlacchia. among the wolves, wandering from one precipice to another, exposed to the severity of the seasons, and frequently languish in want of the necessaries of life, in the most hideous and solitary caverns. Yet they very seldom disturb the tranquillity of others, and prove always faithful guides to travellers; the chief objects of their rapine being sheep and oxen, to supply themselves with food and shoes. Sometimes it happens, that, in their extreme necessity, the Haiduks go in parties to the shepherds cottages, and rudely demand something to eat; which they do not fail to take immediately by force if the least hesitation is made. It is seldom indeed that they meet with a refusal, or with resistance, as their resolution and fury are well known to be equal to the savage life they lead. Four Haiduks are not afraid to assault a caravan of 15 or 20 Turks, and generally plunder and put them to flight. The greatest part of the Haiduks look upon it as a meritorious action to shed the blood of the Turks; to which cruelty they are easily led by their natural ferocity, inflamed by a mistaken zeal for religion, and the discourses of their fanatic priests.

As to the Morlacchi themselves, they are represented as open and sincere to such a degree, that they would be taken for simpletons in any other country; and by means of this quality they have been so often duped by the Italians, that the *faith of an Italian*, and the *faith of a dog*, are synonymous among the Morlacchi. They are very hospitable to strangers, and their hospitality is equally conspicuous among the rich and poor. The rich prepares a roasted lamb or sheep, and the poor with equal cordiality offers whatever he has; nor is this generosity confined to strangers, but generally extends itself to all who are in want. When a Morlack is on a journey, and comes to lodge at a friend's house, the eldest daughter of the family, or the new-married bride if there happens to be one, receives and kisses him when he alights from his horse or at the door of the house: but a foreigner is rarely favoured with these female civilities; on the contrary, the women, if they are young, hide themselves, and keep out of his way.

The Morlacchi in general have little notion of domestic economy, and readily consume in a week as much as would be sufficient for several months, whenever any occasion of merriment presents itself. A marriage, the holiday of the saint, protector of the family, the arrival of relations or friends, or any other joyful incident, consumes of course all that there is to eat and to drink in the house. Yet the Morlack is a great economist in the use of his wearing-apparel; for, rather than spoil his new cap, he takes it off, let it rain ever so hard, and goes bareheaded in the storm. In the same manner he treats his shoes, if the road is dirty and they are not very old. Nothing but an absolute impossibility hinders a Morlack from being punctual; and if he cannot repay the money he borrowed at the appointed time, he carries a small present to his creditor, and requests a longer term. Thus it happens sometimes, that, from term to term, and present to present, he pays double what he owed, without reflecting on it.

Friendship, that among us is so subject to change on the slightest motives, is lasting among the Mor-

lacchi. They have even made it a kind of religious point, and tie the sacred bond at the foot of the altar. The Slavonian ritual contains a particular benediction for the solemn union of two male or two female friends in the presence of the congregation. The male friends thus united are called *Pobratimi*, and the female *Possestrene*, which mean half-brothers and half-sisters. Friendships between those of different sexes are not at this day bound with so much solemnity, though perhaps in more ancient and innocent ages it was also the custom.

From these consecrated friendships among the Morlacchi and other nations of the same origin, it should seem that the *favorn brothers* arose, a denomination frequent enough among the common people of Italy, and in many parts of Europe. The difference between these and the *Pobratimi* of Morlacchia consists not only in the want of the ritual ceremony, but in the design of the union itself. For, among the Morlacchi, the sole view is reciprocal service and advantage; but such a brotherhood among the Italians, is generally commenced by bad men, to enable them the more to hurt and disturb society. The duties of the *Pobratimi* are, to assist each other in every case of need or danger, to revenge mutual wrongs, and such like. The enthusiasm is often carried so far as to risk and even to lose their life for the *Pobratimi*, although these savage friends are not celebrated like a *Pyldades*. If discord happens to arise between two friends, it is talked of over all the country as a scandalous novelty; and there has been some examples of it of late years, to the great affliction of the old Morlacchi, who attribute the deprivation of their countrymen to their intercourse with the Italians. Wine and strong liquors, of which the nation is beginning to make daily abuse, will of course produce the same bad effects as among others.

But as the friendships of the Morlacchi are strong and sacred, so their quarrels are commonly unextinguishable. They pass from father to son; and the mothers fail not to put their children in mind of their duty to revenge their father if he has had the misfortune to be killed, and to shew them often the bloody skirt and arms of the deed. And so deeply is revenge rooted in the minds of this nation, that all the missionaries in the world would not be able to eradicate it. A Morlack is naturally inclined to do good to his fellow-creatures, and is full of gratitude for the smallest benefit; but implacable if injured or insulted.

A Morlack who has killed another of a powerful family, is commonly obliged to save himself by flight, and to keep out of the way for several years. If during that time he has been fortunate enough to escape the search of his pursuers, and has got a small sum of money, he endeavours to obtain pardon and peace; and that he may treat about the conditions in person, he asks and obtains a safe conduct, which is faithfully maintained, through only verbally granted. Then he finds mediators; and, on an appointed day, the relations of the two hostile families are assembled, and the criminal is introduced, dragging himself along on his hands and feet, the musket, pistol, or cutlafs, with which he committed the murder, hung about his neck; and while he continues in that humble posture, one or more of the relations recites a panegyric on the

Morlach's. the dead, which sometimes rekindles the flames of revenge, and puts the poor prostrate in no small danger. It is the custom in some places for the offended party to threaten the criminal, holding all kind of arms to his throat, and, after much intreaty, to consent at last to accept of his ransom. These pacifications cost dear in Albania; but the Morlacchi make up matters sometimes at a small expence; and every-where the business is concluded with a feast at the offender's charge.

The Morlacks, whether they happen to be of the Roman or of the Greek church, have very singular ideas about religion; and the ignorance of their teachers daily augments this monstrous evil. They are as firmly persuaded of the reality of witches, fairies, enchantments, nocturnal apparitions, and sortileges, as if they had seen a thousand examples of them. Nor do they make the least doubt about the existence of vampires; and attribute to them, as in Transylvania, the sucking the blood of infants. Therefore, when a man dies suspected of becoming a vampire, or *vukodlak*, as they call it, they cut his hams, and prick his whole body with pins; pretending, that after this operation he cannot walk about. There are even instances of Morlacchi, who, imagining that they may possibly thirst for childrens blood after death, intreat their heirs, and sometimes oblige them, to promise to treat them as vampires when they die.

The boldest Haiduk would fly trembling from the apparition of a spectre, ghost, phantom, or such like goblins as the heated imaginations of credulous and prepossessed people never fail to see. Nor are they ashamed, when ridiculed for this terror; but answer, such in the words of Pindar: "Fear that proceeds from spirits, causes even the sons of the gods to fly." The women, as may be naturally supposed, are a hundred times more timorous and visionary than the men; and some of them, by frequently hearing themselves called *witches*, actually believe they are so.

A most perfect discord reigns in Morlachia, as it generally does in other parts, between the Latin and Greek communion, which their respective priests fail not to foment, and tell a thousand little scandalous stories of each other. The churches of the Latins are poor, but not very dirty: those of the Greeks are equally poor, and shamefully ill kept. Our author has seen the curate of a Morlack village sitting on the ground in the church-yard, to hear the confession of women on their knees by his side: a strange posture indeed! but a proof of the innocent manners of those good people, who have the most profound veneration for their spiritual pastors, and a total dependence upon them; who, on their part, frequently make use of a discipline rather military, and correct the bodies of their offending flock with the cudgel. Perhaps this particular is carried to an abuse as well as that of public penance, which they pretend to inflict after the manner of the ancient church. They moreover, thro' the silly credulity of those poor mountaineers, draw illicit profits, by selling certain superstitious scrolls and other scandalous merchandise of that kind. They write in a capricious manner, on the scrolls called *zapiz*, sacred names which ought not to be trifled with, and sometimes adding others very improperly joined. The virtues attributed to these *zapiz* are much of the

same nature as those which the Basilians attributed to Morlach's their monstrously cut stones. The Morlacchi use to carry them sewed to their caps, to cure or to prevent diseases; and they also tie them for the same purpose to the horns of their oxen. The composers of this trumpery take every method to maintain the credit of their profitable trade, in spite of its absurdity, and the frequent proofs of its inutility. And so great has their success been, that not only the Morlacchi, but even the Turks near the borders, provide themselves plentifully with *zapiz* from the Christian priests, which not a little increases their income, as well as the reputation of the commodity. The Morlacchi have also much devotion, and many of the ignorant people in Italy have little less, to certain copper and silver coins of the low empire; or to Venetian coteremporary pieces, which pass among them for medals of St Helen; and they think they cure the epilepsy and such like. They are equally fond of an Hungarian coin called *petizza*, which has the virgin and child on the reverse; and one of these is a most acceptable present to a Morlack.

The bordering Turks not only keep with devotion the superstitious *zapiz*, but frequently bring presents and cause masses to be celebrated to the images of the Virgin; which is doubtless in contradiction to the alcoran; yet when saluted, in the usual manner in that country, by the name of *Jesur*, they do not answer. Hence, when the Morlacchi, or other travellers, meet them on the confines, they do not say, *Huaglian Isur*, "Jesus be praised;" but, *Huaglian Bog*, "God be praised."

Innocence, and the natural liberty of pastoral ages, are still preserved among the Morlacchi, or at least many traces of them remain in the places farthest distant from our settlements. Pure cordiality of sentiment is not there restrained by other regards, and displays itself without any distinction of circumstances. A young handsome Morlack girl, who meets a man of her district on the road, kisses him affectionately, without the least malice or immodest thought; and our author has seen all the women and girls, all the young men and old, kissing one another as they came into the church-yard on a holiday; so that they looked as if they had been all belonging to one family. He hath often observed the same thing on the road, and at the fairs in the maritime towns, where the Morlacchi came to sell their commodities. In times of feasting and merriment, besides the kisses, some other little liberties are taken with the hands, which we would not reckon decent, but are not minded among them; and when they are told of it, they answer, it is only toying, and means nothing. From this toying, however, their amours often take their beginning, and frequently end seriously when the two lovers are once agreed. For it very rarely happens, in places far distant from the coast, that a Morlack carries off a girl against her will, or dishonours her: and were such attempts made, the young woman would, no doubt, be able to defend herself; the women in that country being generally very little less robust than the men. But the custom is for the woman herself to appoint the time and place of being carried off; and the does so in order to extricate herself from other suitors, from whom she may have received some love-token, such as a brass ring, a little



Morlachia. little knife, or such like trifles. The Morlack women keep themselves somewhat neat till they get a husband; but after marriage they abandon themselves totally to a loathsome dirtiness, as if they intended to justify the contempt with which they are treated. Indeed it cannot be said that even the young women have a grateful odour, as they are used to anoint their hair with butter, which soon becoming rancid exhales no agreeable effluvia.

The drets of the unmarried women is the most complex and whimsical, in respect to the ornaments of the head; for when married they are not allowed to wear any thing else but a handkerchief, either white or coloured, tied about it. The girls use a scarlet cap, to which they commonly hang a veil falling down on the shoulders, as a mark of their virginity. The better sort adorn their caps with fringes of silver coins, among which are frequently seen very ancient and valuable ones; they have moreover ear-rings of very curious work, and small silver chains with the figures of half moons fastened to the ends of them. But the poor are forced to content themselves with plain caps; or if they have any ornaments, they consist only of small exotic shells, round glass beads, or bits of tin. The principal merit of these caps, which constitute the good taste as well as vanity of the Morlack young ladies, is to attract and fix the eyes of all who are near them by the multitude of ornaments, and the noise they make on the least motion of their heads. Hence half-moons of silver, or of tin, little chains and hearts, false stones and shells, together with all kind of splendid trumpery, are readily admitted into their head-drets. In some districts, they fix tufts of various coloured feathers, resembling two horns on their caps; in others, tremulous plumes of glais; and in others, artificial flowers, which they purchase in the sea-port towns; and in the variety of those capricious and barbarous ornaments, sometimes a fancy not inelegant is displayed. Their holiday-shifts are embroidered with red silk, and sometimes with gold, which they work themselves while they attend their flocks; and it is surprising to see how nicely this work is executed. Both old and young women wear about their necks large fringes of round glass-beads of various size and colour; and many rings of brass, tin, or silver, on their fingers. Their bracelets are of leather covered with wrought tin or silver; and they embroider their stomachers, or adorn them with beads or shells. But the use of stays is unknown, nor do they put whalebone or iron in the stomacher. A broad woollen girdle furrounds their petticoat, which is commonly decked with shells, and of blue colour, and therefore called *modrina*. Their gown, as well as petticoat, is of a kind of serge; and both reach near to the ankle: the gown is bordered with scarlet, and called *sadak*. They use no *modrina* in summer, and only wear the *sadak* without sleeves over a linen petticoat or shift. The girls always wear red stockings; and their shoes are like those of the men, called *opanke*. The sole is of undressed ox-hide, and the upper part of sheep-skin thongs knotted, which they call *apute*; and these they fasten above the ankles, something like the ancient coturns.

The unmarried women, even of the richest females, are not permitted to wear any other sort of shoes; tho'

after marriage they may, if they will, lay aside the *opanke*, and use the Turkish slippers. The girls keep their hair tressed under their caps, but when married they let it fall dishevelled on the breast; sometimes they tie it under the chin; and always have medals, beads, or bored coins, in the Tartar or American mode, twisted amongst it. An unmarried woman, who falls under the imputation of want of chastity, runs the risk of having her red cap torn off her head publicly in church by the curate, and her hair cut by some relation, in token of infamy. Hence, if any of them happen to have fallen into an illicit amour, they commonly of their own accord lay aside the badge of virginity, and remove into another part of the country.

Nothing is more common among the Morlack than marriages concluded between the old people of the respective families, especially when the parties live at a great distance, and neither see nor know each other, and the ordinary motive of these alliances is the ambition of being related to a numerous and powerful family, famous for having produced valiant men. The father of the future bridegroom, or some other near relation of mature age, goes to ask the young woman, or rather a young woman of such a family, not having commonly any determinate choice. Upon this, all the girls of the house are shewn to him, and he chooses which pleases him best, though generally respecting the right of seniority. A denial in such cases is very rare, nor does the father of the maid inquire much into the circumstances of the family that asks her. Sometimes a daughter of the master is given in marriage to the servant or tenant, as was usual in patriarchal times; so little are the women regarded in this country. On these occasions, however, the Morlack girls enjoy a privilege which ours would also wish to have, as in justice they certainly ought. For he who acts by proxy, having obtained his wife, is obliged to go and bring the bridegroom; and if, on seeing each other, the young people are reciprocally content, the marriage is concluded, but not otherwise. In some parts it is the custom for the bride to go to see the house and family of the proposed husband, before she gives a definitive answer; and if the place or persons are disagreeable to her, she is at liberty to annul the contract. But if she is contented, she returns to her father's house, escorted by the bridegroom and nearest relations. There the marriage-day is appointed; on which the bridegroom comes to the bride's house, attended by all his friends of greatest note, who on this occasion are called *svati*, and are all armed, and on horseback, in their holiday-cloaths, with a peacock's feather in their cap, which is the distinctive ornament used by those who are invited to weddings. The company goes armed, to repulse any attack or ambush that might be intended to disturb the feast: for in old times these encounters were not infrequent, according to the records of many national heroic songs.

The bride is conducted to a church, veiled, and surrounded by the *svati* on horseback; and the sacred ceremony is performed amidst the noise of muskets, pistols, barbaric shouts and acclamations, which continue till she returns to her father's house, or to that of her husband if not far off. Each of the *svati* has his parti-

Morlacchia.

particular inspection, as well during the cavalcade, as at the marriage feast, which begins immediately on their return from church. The parviz precedes all the rest, singing such songs as he thinks suitable to the occasion. The bariactar brandishes a lance with a silken banner fastened to it, and an apple stuck on the point; there are two bariactars, and sometimes four, at the more noble marriages. The itari-ivat is the principal personage of the brigade, and the most respectable relation is commonly invested with this dignity. The itacheo's duty is to receive and obey the orders of the itari-ivat. The two diveri, who ought to be the bridegroom's brothers when he has any, are appointed to serve the bride. The knum corresponds to our sponsors; and the komorgia, or sekfana is deputed to receive and guard the dowery. A ciaoous carries the mace, and attends to the order of the march, as master of the ceremonies; he goes singing aloud, *Breberis, Davori, Dobrafitchia, Yara, Pico*, names of ancient propitious deities. Buklia is the cup-bearer of the company, as well on the march as at table; and all these offices are doubled, and sometimes tripled, in proportion to the number of the company.

The first day's entertainment is sometimes made at the bride's house, but generally at the bridegroom's, whither the ivati hasten immediately after the nuptial benediction; and at the same time, three or four men run on foot to tell the good news; the first who gets to the house has a kind of towel, embroidered at the ends, as a premium. The domachin, or head of the house, comes out to meet his daughter-in-law; and a child is handed to her, before she alights, to carefs it; and if there happens to be none in the house, the child is borrowed from one of the neighbours. When she alights, she kneels down, and kisses the threshold. Then the mother-in-law, or, in her place, some other female relation, presents a corn-sieve, full of different kinds of grain, nuts, almonds, and other small fruit, which the bride scatters upon the ivati, by handfuls behind her back. The bride does not sit at the great table the first day, but has one apart for herself, the two diveri, and the itacheo. The bridegroom sits at table with the ivati; but in all that day, consecrated to the matrimonial union, he must neither unloosen or cut any thing whatever. The knum carves his meat, and cuts his bread. It is the domachin's business to give the toasts; and the itari-ivat is the first who pledges him. Generally the bukkara, a very large wooden cup, goes round, first to the saint protector of the family; next to the prosperity of the holy faith; and sometimes to a name the most sublime and venerable. The most extravagant abundance reigns at these feasts; and each of the ivati contributes, by sending a share of provisions. The dinner begins with fruit and cheese; and the soup comes last, just contrary to our custom. All sorts of domestic fowls, kid, lamb, and sometimes venison, are heaped in prodigal quantities upon their tables; but very rarely a Morlacco eats veal, and perhaps never, unless he has been persuaded to do it out of his own country. This abhorrence to calves flesh is very ancient among the Morlacchi. St Jerom, against Jovinian, takes notice of it; and Tomo Marnavich, a Bosnian writer, who lived in the beginning of the last age, says, that the Dalmatians,

un corrupted by the vices of strangers, abstained from eating calves-flesh, as an unclean food, even to his days. The women-relations, if they are invited, never dine at table with the men, it being an established custom for them to dine by themselves. After dinner, they pass the rest of the day in dancing, singing ancient songs, and in games of dexterity, or of wit and fancy; and in the evening, at a convenient hour after supper, the three ritual healths having first gone round, the knum accompanies the bridegroom to the matrimonial apartment, which commonly is the cellar or the stable, whither the bride is also conducted by the diveri and the itacheo; but the three last are obliged to retire, and the knum remains alone with the new-married couple. If there happens to be any bed prepared better than straw, he leads them to it; and having untied the bride's girdle, he caresses them both to undress each other reciprocally. It is not long since the knum was obliged to undress the bride entirely; but that custom is now out of use; and, instead of it, he has the privilege of kissing her as often as he pleases, wherever he meets her; which privilege may possibly be agreeable for the first months, but must soon become very disagreeable. When they are both undressed, the knum retires, and stands listening at the door, if there be a door. It is his business to announce the consummation of the marriage, which he does by discharging a pistol, and is answered by many of the company. The next day, the bride, without her veil and virginal cap, dines at table with the ivati, and is forced to hear the coarse equivocal jests of her indelicat, and sometimes intoxicated, company.

These nuptial-feasts, called *šrave* by the ancient Huns, are by our Morlacchi called *šravizzo*, from whence our Italian word *šravizzo* is undoubtedly derived. They continue three, six, eight, or more days, according to the ability or prodigal disposition of the family where they are held. The new-married wife gets no inconsiderable profit in these days of joy. And it usually amounts to much more than all the portion she brings with her, which often consists of nothing but her own cloaths, and perhaps a cow; nay, it happens sometimes that the parents, instead of giving money with their daughter, get something from the bridegroom by way of price. The bride carries water every morning, to wash the hands of her guests, as long as the feasting lasts; and each of them throws a small piece of money into the basin, after performing that function, which is a very rare one among them excepting on such occasions. The brides are also permitted to raise other little contributions among the ivati, by hiding their shoes, caps, knives, or some other necessary part of their equipage, which they are obliged to ransom by a piece of money, according as the company rates it. And, besides all these voluntary or extorted contributions already mentioned, each guest must give some present to the new married wife at taking leave the last day of the *šravizzo*; and then she also distributes some trifles in return, which commonly consist in shirts, caps, handkerchiefs, and such like.

The nuptial-rites are almost precisely the same thro' all the vast country inhabited by the Morlacchi; and those in use among the peasants and common people of the sea-coast of Dalmatia, Istria, and the islands, differ

differ but little from them. Yet among these particular varieties, there is one of the island Zlarine, near Sebenico, remarkable enough; for there the Itarivat (who may naturally be supposed drunk at that hour) malt, at one blow, with his naked broad sword, strike the bride's crown of flowers off her head, when she is ready to go to bed. And in the island of Pago, in the village of Novoglia, (probably the Gilla of ancient geographers), there is a custom more comical, and less dangerous, but equally savage and brutal. After the marriage-contract is settled, and the bridegroom comes to conduct his bride to church; her father or mother, in delivering her over to him, makes an exaggerated enumeration of her ill qualities: "Know, since thou wilt have her, that she is good for nothing, ill-natured, obstinate, &c." On which the bridegroom, affecting an angry look, turns to the young woman, with an, "Ah! since it is so, I will teach you to behave better;" and at the same time regales her with a blow or a kick, or some piece of similar gallantry, which is by no means figurative. And it seems in general, that the Morlack women, and perhaps the greatest part of the Dalmatians, the inhabitants of the cities excepted, do not dislike a beating, either from their husbands or lovers.

In the neighbourhood of Derrish, the women are obliged, during the first year after marriage, to kiss all their national acquaintances who come to the house; but after the first year they are dispensed from that compliment; and indeed they become so intolerably nasty, that they are no longer fit to practise it. Perhaps the mortifying manner in which they are treated by their husbands and relations, is, at the same time, both the cause and effect of this shameful neglect of their persons. When a Morlack husband mentions his wife, he always premises, by your leave, or begging your pardon. And when the husband has a bedhead, the wife must sleep on the floor near it. Our author often lodged in Morlack houses, and observed that the female sex is universally treated with contempt: it is true, that the women are by no means amiable in that country; they even deform and spoil the gifts of nature.

The pregnancy and births of those women would be thought very extraordinary among us, where the ladies suffer so much, notwithstanding all the care and circumspection used before and after labour. On the contrary, a Morlack woman neither changes her food nor interrupts her daily fatigue, on account of her pregnancy; and is frequently delivered in the fields, or on the road, by herself; and takes the infant, washes it in the first water she finds, carries it home, and returns the day after to her usual labour, or to feed her flock.

The little creatures, thus carelessly treated in their tenderest moments, are afterwards wrapt in miserable rags, where they remain three or four months, under the same ungentle management; and when that term is elapsed, they are set at liberty, and left to crawl about the cottage and before the door, till they learn to walk upright by themselves; and at the same time acquire that singular degree of strength and health with which the Morlacchi are endowed, and are able, without the least inconvenience, to expose their naked breasts to the severest frost and snow. The infants are

allowed to suck their mother's milk while she has any, or till she is with child again; and if that should not happen for three, four, or six years, they continue all that time to receive nourishment from the breast. The prodigious length of the breasts of the Morlacchian women is somewhat extraordinary; for it is very certain, that they can give the teat to their children over their shoulders, or under their arms. They let the boys run about, without breeches, in a shirt that reaches only to the knee, till the age of 13 or 14, following the custom of Boffina, subject to the Porte, where no haraz or capitation-tax is paid for the boys till they wear breeches, they being considered before that time as children, not capable of labouring, or of earning their bread. On the occasion of births, and especially of the first, all the relations and friends send presents of estates to the woman in childbed, or rather to the woman delivered; and the family makes a supper of all those presents together. The women do not enter the church till 40 days after child-birth.

The Morlacchi pass their youth in the woods, attending their flocks and herds, and in that life of quiet and leisure they often become dexterous in carving with a simple knife; they make wooden cups, and whistles adorned with fanciful bass-reliefs, which are not void of merit, and at least shew the genius of the people.

MORLEY (George), bishop of Winchester, was the son of Francis Morley, Esq; and was born at London in 1597. He was educated at Christ-church, Oxford, of which he had the canony in 1641, and the next year was made doctor of divinity. He had also several church-preferments, of which he was deprived by the parliament visitors in the beginning of the year 1648. After this, king Charles I. sent for him to assist at the treaty of the Isle of Wight. After the king's death he attended the lord Capel at his execution, and then retired to Charles II. at the Hague, on whom he constantly waited till his majesty went to Scotland, when he retired to Antwerp, where he read the service of the church of England, as he afterwards did at Breda. At the Restoration he was first made dean of Christ-church, and in 1660 was consecrated bishop of Worcester, and soon after was made dean of the royal chapel. In 1662 he was translated to the bishopric of Winchester, when he bestowed considerable sums on that see, in repairing Farnham-castle and his palace at Westminster, and in purchasing Winchester-house at Chelsea. He died at Farnham-castle in 1684. He was a Calvinist, and before the wars was thought a friend to the Puritans; but after his promotion, he took care to free himself from all suspicions of that kind. He was a pious and charitable man, of a very exemplary life, but extremely passionate. He published, 1. *Epistola apologetica et parænetica ad theologum quendam Belgam scripta*, in 4to. 2. The sum of a short conference between Father Darcy a Jesuit, and Dr Morley at Brussels. 3. An argument drawn from the evidence and certainty of sense against the doctrine of Transubstantiation. 4. A letter to Anne duchess of York. 5. Several sermons, and other pieces.

MORNAY (Philip de), lord of Pleffis-Marly, governor of Saumur, and one of the best Protestant generals of France, was born of a noble family at Buhy

Morning,  
Morocco.

in 1549. He became well skilled in polite literature, divinity, and the learned languages. Having embraced the Protestant religion, he travelled to Italy, Germany, the Netherlands, and to England; and at length engaged himself in the interest of the king of Navarre, who was afterwards Henry the Great. That prince relied greatly on his judgment, and in 1590 made him counsellor of state. De Pleffis performed the most important services for him, and was one of the lords who contributed most to his ascending the throne. He was in a manner the head and soul of the Protestants; he had their entire confidence, and acquired great reputation amongst them on account of his learning, valour, and probity; which occasioned his being called the *Pope of the Huguenots*. He opposed king Henry IV.'s embracing the Romish religion to the utmost of his power; and soon after that event retired from court, and laboured at his famous work on the Eucharist. He continued to support the Calvinists party by his writings; and Lewis XIII. taking from him the government of Saumur in 1621, he retired to his barony at Forêt-sur-Seure in Poitou, where he died in 1623, aged 74. He also wrote, 1. A treatise on the truth of the Christian religion. 2. The mystery of iniquity; and other works.

**MORNING**, the beginning of the day, the first appearance of light, or the time from midnight till noon.

**MOROCCO**, an empire of Africa, comprehending a considerable part of the ancient Mauritania, is bounded on the west by the Atlantic Ocean; on the east by the river Muluya, which separates it from Algiers; on the north by the Mediterranean; and on the south by mount Atlas, or rather by the river Sus, which divides it from the kingdom of Tafilet. Its greatest length is from the north-east to the south-west, amounting to above 590 miles; its breadth is not above 260 where broadest, and in the most narrow places is not above half that breadth.

The ancient history of Morocco hath been already given under the article MAURITANIA. It continued under the dominion of the Romans upwards of 400 years. On the decline of that empire it fell under the Goths, who held it till about the year 600, when the Goths were driven out by the Vandals, the Vandals by the Greeks, and they in their turn by the Saracens, who conquered not only this empire, but we may say the whole continent of Africa; at least their religion, one way or other, is to be found in all parts of it. The Saracen empire did not continue long united under one head, and many princes set up for themselves in Africa as well as elsewhere, through whose dissensions the Almoravides were at length raised to the sovereignty, as related under the article ALGIERS, n<sup>o</sup> 2. Yusuf, or Joseph, the second monarch of that line, built the city of Morocco, conquered the kingdom of Fez, and the Moorish dominions in Spain; all which were lost by his grandson Abu Hali, who was defeated and killed by the Spaniards. On this prince's death the crown passed to the Mohedians, or Almohedes, with whom it had not continued above three generations, when Mohammed the son of Al Mansur lost the famous battle of Sierra Morena, in which 200,000 Moors were slain,

and in consequence of which Alphonso X. retook a great many of the Moorish conquests immediately after.

Mohammed died soon after this disgrace, and left several sons, between whom a civil war ensued, during which the viceroys of Fez, Tunis, and Tremelen, found means to establish themselves as independent princes. At length one of the princes of the royal blood of Tremelen having defeated the Almohedes, made himself master of the kingdoms of Morocco and Fez, and entailed them on his own family. In a short time, however, this family was expelled by the Merini, the Merini by the Oatazes, and these by the Sharifs of Fafcen, who have kept the government ever since.

This happened about the year 1516; and since that time the history of the empire affords nothing remarkable. What we have under that name is indeed nothing else than a catalogue of the enormous vices and excesses of the emperors and people. Nothing indeed can be conceived more unjust and despotic than the government of Morocco, and nothing more degenerate than the characters of the people. The emperor is allowed to have not only an uncontrollable power over the lives and fortunes of his subjects, but in a great measure over their consciences, such as they are; in as much as he is the only person who, as the successor of the prophet, hath a right to interpret the Koran; and appoints all the judges under him, of whom those of Morocco and Fez are the chief, whose business it is to explain and dispense all matters relating to their religion; and, being his creatures and dependents, dare not steer otherwise than as he directs. Whenever therefore the laws are enacted by him, and proclaimed by his governors in all the provinces, as is commonly done, that none may plead ignorance, they are everywhere received with an implicit and religious submission. On the other hand, the subjects are bred up with a notion, that those who die in the execution of his command are entitled to an immediate admittance into paradise, and those who have the honour to die by his hand to a still greater degree of happiness in it. After this we need not wonder at finding so much cruelty, oppression, and tyranny on the one side, and so much submission, passiveness, and misery on the other.

This latter, however, extends no farther than the Moors: for as to the Arabs, the subjection and tribute they pay to those tyrants was always involuntary, and altogether forced; and as for the negroes, their zeal and attachment is owing merely to the great sway and power which they have gained in the government, both on account of their being better soldiers than the Moors, and from a particular regard which Muley Ishmael a late emperor had for them on account of his mother being a negro; so that, being now grown in a manner too strong to be suppressed, their loyalty and affection to those monarchs, whom they strive to imitate in all their vices, must be supposed to rise and fall according to the favour and encouragement they receive from them. And they are now the only ones to whom those tyrants entrust their persons, their treasure, and their concubines; whom they raise to the highest posts of authority and trust; and whom they suffer, not to say encourage by their

Morocco.

Morocco. their own example, to tyrannize and oppress their native, as well as their most faithful and submissive subjects.

These negroes, ever since their adhering so closely to Muley Ithmael, have been in high request with his successors, and make the main branch of the soldiery both of horse and foot. They are brought for young out of Guinea, that they quickly lose the memory of it; and having no relations or friends, nor dependence but on the emperor's favour, are the more ready to obey his orders in all things. They are at first brought up to be foot-soldiers; and after so many years service in it, or sooner if their behaviour deserve it, are advanced to the cavalry, which is a great honour in that country. They are taught little else except the exercise of arms, and to obey the emperor's orders; and, by the readiest compliance with his views, politics, and inclination, advance themselves to the highest posts under him.

But we shall perhaps find less reason to wonder at this connivance, if we consider, that, sooner or later, all the extortions of those blood-suckers come in course into their own treasury, either by the heavy fines they impose upon them upon any complaint preferred against them, or upon any other, whether real or pretended, mal-administrations, or by seizing on all their ill-gotten wealth at their deaths. For the emperors here have found means to establish another branch of despotism, which renders them still more powerful and formidable to their subjects; viz. their making themselves their sole heirs, and, in virtue of that, seizing upon all their effects, and making only such provision for their families as they think proper; and often, on some frivolous pretence, leaving them destitute of any, according to the liking or dislike they bear to the deceased: so that, upon the whole, they are the only makers, judges, and interpreters, and in many instances likewise the executioners, of their own laws, which have no other limits than their own arbitrary will. To preserve, however, some specious show or shadow of justice, they allow their musti a kind of superiority in spirituals, and a sort of liberty to the meanest subject to summon them before his tribunal. But the danger which such an attempt would bring upon a plaintiff, perhaps no less than death and destruction, is of itself sufficient to deter any man from it; especially considering the little probability there is that the judges of it would run the risk of declaring themselves against a monarch whose creatures they are, and on whom their lives and fortunes so absolutely depend.

The titles which the emperors of Morocco assume, are those of *Most glorious, mighty, and noble emperor of Afric, king of Fez and Morocco, Taphilet, Suz, Darba, and all the Algarbe, and its territories in Afric; grand Sharif* (or, as others write it, *Karif*; that is, "successor, or vicegerent,") of the great prophet *Mohammed, &c.*

The judges or magistrates that act immediately under him, are either spiritual or temporal, or rather ecclesiastic and military. The musti and the kadis are judges of all religious and civil affairs; and the bashas, governors, alcaides, and other military officers, of those that concern the state or the army. All of them the most obsequious creatures and slaves of their

prince, and no less the rapacious tyrants of his subjects, and from whom neither justice nor favour can be obtained but by mere dint of money, and extortionate bribery, from the highest to the lowest. Neither can it indeed be otherwise in such an arbitrary government, where the highest posts must not only be bought of the prince at a most exorbitant price, and kept only by as exorbitant a tribute, which is yearly paid to him, but where no one is sure to continue longer than he can bribe some of the courtiers to insinuate to the monarch that he pays to the utmost of his power, and much beyond what was expected from him. Add to this, that those bashas, governors, &c. are obliged to keep their agents and spies in constant pay at court, to prevent their being supplanted by higher bidders, slanderers, or other artful underminers.

From what hath been said under this head, it may be reasonably concluded that this branch of the imperial revenue must be very considerable, though there is no possibility to make any other conjecture of its real amount, than that it must be an immense one. Another considerable branch is the piratical trade, which brings the greater income into his treasury, as he is not at any expence either for fitting of corsair vessels out, or maintaining their men: and yet hath the tenth of all the cargo, and of all the captives; besides which, he appropriates to himself all the rest of them, by paying the captors 50 crowns *per head*; by which means he engrosses all the slaves to his own service and advantage. This article is indeed a very considerable addition to his revenue, not only as he sells their ransom at a very high rate, but likewise as he hath the profit of all their labour, without allowing them any other maintenance than a little bread and oil, nor any other assistance when sick than what medicines a Spanish convent, which he tolerates there, gives them gratis; and which, nevertheless, is forced to pay him an annual present for that toleration, besides furnishing the court with medicines, and the slaves with lodging and diet when they are not able to work. Another branch of his revenue consists in the tenth part of all cattle, corn, fruits, honey, wax, hides, rice, and other products of the earth, which is exacted of the Arabs and Berbers, as well as of the natives; and these are levied, or rather farmed, by the bashas, governors, alcaides, &c. with all possible severity. The Jews and Christians likewise pay an income or capitation, the former of six crowns *per head* on all males from 15 years and upwards, besides other arbitrary imposts, fines, &c. That on the Christians, for the liberty of trading in his dominions, rises and falls according to their number, and the commerce they drive; but which, whatever it may bring yearly into his coffers, is yet detrimental to trade in general, seeing it discourages great numbers from settling there, notwithstanding the artful invitations which the emperors and their ministers make use of to invite them to it; for, besides those arbitrary exactions, there is still another great hardship attending them, viz. that they cannot leave the country without forfeiting all their debts and effects to the crown. The duties on all imports and exports is another branch of his income, the amount of which, *communibus annis*, no author hath yet given us any account of; only counsellor Hatfield hath computed the whole yearly revenue,

Morocco. venue, including ordinaries and extraordinaries, to amount to 500 quintals of silver, each quintal, or 100 lb. weight, valued at somewhat above 330l. Sterling; so that the whole amounts to no more, according to him, than 165,000l.; a small revenue indeed for so large an empire, if the calculation may be depended upon. But St Olan, though he doth not pretend so much as to guess at the yearly amount of it, doth in general represent it as so considerable, that Muley Ithmael was reckoned to have amassed out of it a treasure in gold and silver of about 50 effective millions; but whether of crowns or livres he doth not tell us, nor how he came by his knowledge of it; because that politic prince, even by his own confession, not only caused all his riches to be buried in sundry places under-ground, his gold and silver to be melted into great lumps, and laid in the same privacy under-ground, but likewise all those whom he entrusted with the secret to be as privately murdered. However that be, we shall, upon the whole, have the less cause to wonder at these exorbitant exactions which he extorts from Christian princes and states, whenever they are obliged either to seek his alliance, or to obtain some redress in favour of their trading subjects; much less at the shameful delays, insults, extortions, indignities, and injustice, which their ambassadors must be content to put up with, to obtain the least favour from their rapacious ministers.

The air of this country, though hot and dry, is pleasant and healthy, the winds from the sea and mount Atlas refreshing the inhabitants in the hottest season.

As to the soil, it is neither so mountainous, sandy, or barren, as many other parts of Africa; but produces, or would produce if duly cultivated, vast quantities of corn, wine, and oil. No country affords better wheat, barley, or rice: both the French and Spaniards fetch these from the Barbary coast, when they have a scarcity at home; and our garrisons of Gibraltar and Port-Mahon are often supplied with provisions from thence. The plains of Fez and Morocco are well planted with olives: and there are no better grapes for making wine in the world, as the Jews at Tetuan experience; though the cultivation of vines is not encouraged among the Mahomedans, in consequence of the precept in the Koran, forbidding the drinking of wine. Here are also other fruits, as dates, figs, raisins, almonds, apples, pears, cherries, plums, citrons, lemons, oranges, pomegranates, with plenty of roots and herbs, hemp, flax, sugar, honey, and wax: but they have not many forest-trees, and scarce any good timber; possibly their soil is not proper for timber, or they take no care to preserve it, having little occasion for any.

The animals of this part of Africa, whether wild or tame, are much the same we meet with to the southward; except the elk, the elephant, and the rhinoceros, which no travellers pretend to meet with in the empire of Morocco: and as they want these, so they have some others not to be found in the south of Africa, particularly camels, dromedaries, and that fine breed of horses called *barbs*, which for their beauty and swiftness can scarce be paralleled in the world. Nor are their horses to be admired only for their beauty and speed, but their use in war, being extremely ready

Morocco. to obey their riders upon the least sign, in charging, wheeling, or retiring; so that the trooper has his hands very much at liberty, and can make the best use of his arms.

As to mountains, the chief are that chain which goes under the name of *Mount Atlas*, and runs the whole length of Barbary from east to west, passing through Morocco, and abutting upon that ocean which separates the eastern from the western continent, and is from this mountain called the *Atlantic Ocean*. This mountain, as the poets feigned, sustained the universe; hence we see Atlas represented with the world upon his shoulders, and descriptions of the globe or sets of maps dignified with the name of *Atlas*. Dr Shaw, however, assures us, that this chain cannot stand in competition either with the Alps or Appennines for height. Near the Straits stands the mountain anciently called *Alysia*, and now, if we are not mistaken, by our countrymen styled the *Apex-hill*.

The principal rivers, besides the Malva or Mulvia above-mentioned, which rises in the deserts, and running from south to north divides Morocco from the kingdom of Algiers, are the Suz, Onmirabil, Rabbata, Larache, Darodt, Sebon, Gueron, and Tenift, which rise in Mount Atlas, and fall into the Atlantic Ocean.

The chief capes are Cape Threeforks on the Mediterranean, Cape Spertal at the entrance of the straits, Cape Cantin, Cape None, and Cape Rajador, on the Atlantic Ocean.

Of the bays the most considerable are, the bay of Tetuan in the Mediterranean, and the bay of Tanger in the straits of Gibraltar.

There are some mines of very fine copper in this empire; but if there are any of gold and silver, as some writers tell us, they have never been opened, as far as we can find.

The traffic of the empire by land is either with Arabia or Negroland: to Mecca they send caravans, consisting of several thousand camels, horses, and mules, twice every year, partly for traffic, and partly upon a religious account; for numbers of pilgrims take that opportunity of paying their devotions to their great prophet. The goods they carry to the east are woollen manufactures, very fine Morocco skins, indigo, cochineal, and ostrich feathers; and they bring back from thence, silk, muslins, and drugs. By their caravans to Negroland, they send salt, silk, and woollen manufactures, and bring back gold and ivory in return, but chiefly negroes: for from hence it is that their emperor chiefly recruits his black cavalry, though there are also great numbers born in the country; for they bring those of both sexes very young from Negroland, the females for breeders, and the males for soldiers. As they grow up, they first carry a musket, and serve on foot, and after some time are preferred to be cavaliers: and as they have no other hopes or dependence but the favour of the emperor, they prove much the most dutiful and obsequious of all his subjects, and indeed support his tyranny over the rest.

The caravans always go strong enough to defend themselves against the wild Arabs in the deserts of Africa and Asia; though, notwithstanding all their vigilance, some of the stragglers and baggage often fall

Morocco.

fall into their hands: they are also forced to load one half of their camels with water, to prevent their perishing with drought and thirst in those inhospitable deserts. And there is still a more dangerous enemy, and that is the sand itself: when the winds rise, the caravan is perfectly blinded with dust; and there have been instances both in Africa and Asia, where whole caravans, and even armies, have been buried alive in the sands. There is no doubt also, but that men and cattle are sometimes surpris'd by wild beasts, as well as robbers, in those vast deserts; the hot winds also, blowing over a long tract of burning sand, are equal almost to the heat of an oven, and destroy abundance of merchants and pilgrims. If it was not for devotion, and in expectation of very great gains, no man would undertake a journey in these deserts; great are the hazards and fatigues they must of necessity undergo; but those that go to Mecca assure themselves of paradise if they die, and have uncommon honours paid them at home if they survive. People crowd to be taken into the eastern caravans; and the gold that is found in the fouth, make them no less eager to undertake that journey.

The natives have hardly any trading vessels, but are seldom without some corsairs. These, and European merchant-ships, bring them whatever they want from abroad; as linen and woollen cloth, stuffs, iron wrought and unwrought, arms, gunpowder, lead, and the like: for which they take in return, copper, wax, hides, Morocco leather, wool, (which is very fine) gums, soap, dates, almonds, and other fruits.

The coins of this empire are a *fluce*, a *blanqui*, and *ducat*. The *fluce* is a small copper coin, twenty whereof make a *blanqui*, of the value of two-pence Sterling. The *blanqui* is of silver, and the *ducat* of gold, not unlike that of Hungary, and worth about nine shillings. Both these pieces are so liable to be clipped and filed by the Jews, that the Moors always carry scales in their pockets to weigh them; and when they are found to be much diminished in their weight, they are received by the Jews, who are masters of the mint, by which they gain a considerable profit; as they do also by exchanging the light pieces for those that are full weight. Merchants accounts are kept in *bunces*, ten of which make a *ducat*; but in payments to the government, it is said they will reckon seventeen one-half for a *ducat*.

With respect to religion, the inhabitants of Morocco are Mohammedans, of the sect of Ali; and have a *muffi*, or high-priest, who is also the supreme civil magistrate, and the last resort in all causes ecclesiastical and civil. They have a great veneration for their hermits, and for idiots and madmen; as well as for those who by their tricks have got the reputation of wizzards; all whom they look upon as inspired persons, and not only honour as saints while they live, but build tombs and chapels over them when dead; which places are not only devoutly visited by their devotees far and near, but are esteem'd inviolable sanctuaries for all sorts of criminals, except in cases of treason.

Notwithstanding the natives are zealous Mohammedans, they allow foreigners the free and open profession of their religion, and their very slaves have their

Morocco.

priests and chapels in the capital city, though it must be owned that the Christian slaves are here treated with the utmost cruelty. Here, as in all other Mohammedan countries, the alcoran and their comments upon it are their only written laws; and though in some instances their *cadis*, and other civil magistrates, are controlled by the arbitrary determinations of their princes, *bashaws*, generals, and military officers, yet the latter have generally a very great deference and regard for their laws. Murder, theft, and adultery, are commonly punished with death: and their punishments for other crimes, particularly those against the state, are very cruel; as impaling, dragging the prisoner through the streets at a mule's heels, till all his flesh is torn off; throwing him from a high tower upon iron hooks; hanging him upon hooks till he die; crucifying him against a wall; and, indeed, the punishment and condemnation of criminals is in a manner arbitrary. The emperor, or his *bashaws*, frequently turn executioners; shoot the offender, or cut him to pieces with their own hands, or command others to do it in their presence.

In regard to the character of the Moors, they are said to be a covetous inhospitable people, intent upon nothing but heaping up riches, to obtain which they will be guilty of the meanest things, and stick at no manner of fraud. The Arabs also, who are almost as numerous as the Moors, have always had the character of a pilfering generation. The people who inhabit the hills, and who have the least to do with the court and with traffic, are much the honestest people among them, and still retain a good share of liberty, the government using them rather as allies than subjects, lest they should entirely disown their authority. The Moors, however, with all their bad qualities, are observed to be very dutiful to their parents, their princes, and superiors. A plurality of wives is allowed here, as in other Mohammedan countries; nor do they confine themselves to women, but keep boys, as they do in Turkey. The woman who commits adultery is punished with death; but it is not difficult for them to obtain a divorce, if ill used.

The dead are carried to the grave in their usual dress, the priests singing before them, *La illa All illa, Mahomet Resoul Allah*, i. e. God is a great God, and Mahomet his prophet.

The Moors, or natives of the country, are of much the same complexion as the Spaniards on the opposite shore; but such multitudes of negroes have been brought from Guinea, that you see almost as many black as white people, especially about Mequinez, where the court resides. The habit of a Moor is a linen frock or shirt next his skin, a vest of silk or cloth tied with a sash, a pair of drawers, a loose coat, his arms bare to the elbow, as well as his legs, sandals or slippers on his feet, and sometimes people of condition wear buskins; they shave their heads, and wear a turban, which is never pulled off before their superiors, or in their temples; they express their reverence both to God and man by pulling off their slippers, which they leave at the door of the mosque or palace; and, when they attend their prince in the city, they run bare-foot after him, if the streets are ever so dirty. Their turbans are of fine silk, or fine linen. The habit of the women is not very different

from

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Mortar.

from that of the men, except that they wear a fine linen cloth or caul on their heads, instead of a turban, and their drawers are much larger and longer than the mens. The women also, when they go abroad, have a linen cloth over their faces, with holes in it for their eyes, like a mask.

MOROCCO, the capital city of the kingdom of Morocco, in Barbary; seated in a very large plain, 250 miles south by west of Fez, 125 north-west of Suez, and 15 from Mount Atlas. It was surrounded by a strong wall, fortified with towers and some bulwarks, and encompassed with deep ditches. The number of houses were reckoned formerly to be 100,000, all with flat roofs; but they are now greatly diminished, inasmuch that the greatest part of the city is unpeopled. The irruptions and robberies of the Arabs hinder them from cultivating the lands about it, inasmuch that there is nothing but vines, date-trees, and some other fruits. There were three temples or mosques in this place, of a prodigious size; and the emperor's palace was so large, and took up so much ground, that it resembled a small city. A late traveller affirms, that the inhabitants now are not above 25,000, and that the houses go to ruin every day, without being rebuilt. This may happen partly from the removal of the court, which is now at Mequinez. W. Long. 6. 45. N. Lat. 30. 32.

MOROCCO, or *Turkey-leather*. See LEATHER.

MOROCHTHUS, in natural history, an indurated clay called by us *French chalk*; serving taylors and others to mark with. The ancients esteemed it as an astringent, prescribing it in the colic, hemorrhages, and other fluxes.

MORON, a town of Spain, in Andalusia, seated in a pleasant fertile plain, and in the neighbourhood of a mine of precious stones. It is 30 miles south-east of Seville. W. Long. 5. 20. N. Lat. 37. 0.

MORPETH, a handsome town of Northumberland, which sends two members to parliament. The most remarkable particular concerning it is a story of its being reduced to ashes by its own inhabitants on the approach of king John in 1215, out of pure hatred to their monarch, that he might find no shelter there.

MORPHEUS, in fabulous history, the god of sleep, or, according to others, one of the ministers of Somnus. He caused sleepiness, and represented the forms of dreams. Ovid styles him the kindest of the deities; and he is usually described in a recumbent posture, and crowned with poppies.

MORSE, in zoology. See TRICHECUS.

MORTALITY, or *Bills of MORTALITY*, properly denote lists of the persons who die in any place. See ANNUITIES.

BRIEF of MORTANCESTRY, in Scots law; anciently the ground of an action at the instance of an heir, in the special case where he had been excluded from the possession of his ancestor's estate by the superior, or other person pretending right.

MORTAR, a preparation of lime and sand mixed with water, which serves as a cement, and is used by masons and bricklayers in building walls of stone and brick.

Under the article CEMENT, we have already given the theory of mortar, as delivered by Mr Anderson;

Mortar.

which hath now received a farther confirmation by a recent discovery, that if the lime is slaked, and the mortar made up with lime-water instead of common water, the mortar will be much better. The reason of this is, that in common water, especially such as is drawn from wells, there is always a considerable quantity of fixed air, which, mingling with the mortar previous to its being used, spoils it by reducing the quicklime in part to an inert calcareous earth like chalk; but when it is built up in a perfectly caustic state, it attracts the air so slowly, that it hardens into a kind of stony matter as hard as was the rock from whence the limestone was taken.

MORTAR, a chemical instrument very useful for the division of bodies, partly by percussion, and partly by grinding. Mortars have the form of an inverted bell. The matter intended to be pounded is to be put into them, and there it is to be struck and bruised by a long instrument called a *pestle*. The motion given to the pestle ought to vary according to the nature of the substances to be pounded. Those which are easily broken, or which are apt to fly out of the mortar, or which are hardened by the stroke of the pestle, require that this instrument should be moved circularly, rather by grinding or bruising, than by striking. Those substances which are softened by the heat occasioned by rubbing and percussion, require to be pounded very slowly. Lastly, those which are very hard, and which are not capable of being softened, are easily pounded by repeated strokes of the pestle. They require no bruising but when they are brought to a certain degree of fineness. But these things are better learnt by habit and practice than by any directions.

As mortars are instruments which are constantly used in chemistry, they ought to be kept of all sizes and materials; as of marble, copper, glass, iron, griststone, and agate. The nature of the substance to be pounded determines the choice of the kind of mortar. The hardness and dissolving power of that substance are particularly to be attended to. As copper is a soft metal, soluble by almost all menstrua, and hurtful to health, good artists have some time ago proscribed the use of this metal.

One of the principal inconveniences of pulverisation in a mortar proceeds from the fine powder which rises abundantly from some substances during the operation. If these substances be precious, the loss will be considerable; and if they be injurious to health, they may hurt the operator. These inconveniences may be remedied, either by covering the mortar with a skin, in the middle of which is a hole, thro' which the pestle passes; or by moistening the matter with a little water, when this addition does not injure it; or, lastly, by covering the mouth and nose of the operator with a fine cloth, to exclude this powder. Some substances, as corrosive sublimate, arsenic, calxes of lead, cantharides, euphorbium, &c. are so noxious, that all these precautions ought to be used, particularly when a large quantity of them is pounded.

Large mortars ought to be fixed upon a block of wood, so high, that the mortar shall be level with the middle of the operator. When the pestle is large and heavy, it ought to be suspended by a cord or chain fixed to a moveable pole, placed horizontally above the mortar: this pole considerably relieves the

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Mortgage.

the operator, because its elasticity assists the raising of the pille.

**MORTAR PIECE.** See GUN, par. ult. GUNNERY, n<sup>o</sup> 50, 52, 55, and Plate CXXI. and CXLIII. fig. 20.

**MORTGAGE**, in law, (*mortuum vadium*, or dead-pledge,) is where a man borrows of another a specific sum (e. g. 200 l.) and grants him an estate in fee, on condition that if he, the mortgagor, shall pay the mortgagee the said sum of 200 l. on a certain day mentioned in the deed, then the mortgagor may re-enter on the estate so granted in pledge; or, as is now the more usual way, that the mortgagee shall reconvey the estate to the mortgagor: in this case the land which is so put in pledge, is by law, in case of nonpayment at the time limited, for ever dead and gone from the mortgagor; and the mortgagee's estate in the lands is then no longer conditional, but absolute. But, so long as it continues conditional, that is, between the time of lending the money, and the time allotted for payment, the mortgagee is called *tenant in mortgage*. But as it was formerly a doubt, whether, by taking such estate in fee, it did not become liable to the wife's dower, and other incumbrances, of the mortgagee, (though that doubt has been long ago over-ruled by our courts of equity), it therefore became usual to grant only a long term of years, by way of mortgage; with condition to be void on repayment of the mortgage-money: which course has since been continued, principally because on the death of the mortgagee such term becomes vested in his personal representatives, who alone are entitled in equity to receive the money lent, of whatever nature the mortgage may happen to be.

As soon as the estate is created, the mortgagee may immediately enter on the lands; but is liable to be dispossessed, upon performance of the condition by payment of the mortgage-money at the day limited. And therefore the usual way is to agree that the mortgagor shall hold the land till the day assigned for payment; when, in case of failure, whereby the estate becomes absolute, the mortgagee may enter upon it and take possession, without any possibility at law of being afterwards evicted by the mortgagor, to whom the land is now for ever dead. But here again the courts of equity interpose; and though a mortgage be thus forfeited, and the estate absolutely vested in the mortgagee at the common law, yet they will consider the real value of the tenements compared with the sum borrowed. And if the estate be of greater value than the sum lent thereon, they will allow the mortgagor at any reasonable time to re-call or redeem his estate; paying to the mortgagee his principal, interest, and expenses: for otherwise, in strictness of law, an estate worth 1000 l. might be forfeited for non-payment of 100 l. or a less sum. This reasonable advantage, allowed to mortgagors, is called the *equity of redemption*; and this enables a mortgagor to call on the mortgagee, who has possession of his estate, to deliver it back, and account for the rents and profits received, on payment of his whole debt and interest; thereby turning the *mortuum* into a kind of *vivum vadium*; (see **VADIUM**). But, on the other hand, the mortgagee may either compel the sale of the estate, in order to get the whole of his money immediately; or

else call upon the mortgagor to redeem his estate presently, or, in default thereof, to be for ever foreclosed from redeeming the same; that is, to lose his equity of redemption without possibility of recall. And also, in some cases of fraudulent mortgages, the fraudulent mortgagor forfeits all equity of redemption whatsoever. It is not, however, usual for mortgagees to take possession of the mortgaged estate, unless where the security is precarious, or small; or where the mortgagor neglects even the payment of interest: when the mortgagee is frequently obliged to bring an ejectment, and take the land into his own hands, in the nature of a pledge, or the *pignus* of the Roman law: whereas, while it remains in the hands of the mortgagor, it more resembles their hypotheca, which was where the possession of the thing pledged remained with the debtor. But, by statute 7 Geo. II. c. 20. after payment or tender by the mortgagor of principal, interest, and costs, the mortgagee can maintain no ejectment; but may be compelled to re-assign his securities. In Glanvil's time, when the universal method of conveyance was by livery of seisin or corporal tradition of the lands, no gage or pledge of lands was good unless possession was also delivered to the creditor; *si non sequatur ipsius vadii traditio, curia domini regis hujusmodi privatas conventiones tueri non solet*: for which the reason given is, to prevent subsequent and fraudulent pledges of the same land; *cum in tali casto possit eadem res pluribus aliis creditoribus tum prius tum posterius invaditari*. And the frauds which have arisen, since the exchange of these public and notorious conveyances for more private and secret bargains, have well evinced the wisdom of our ancient law.

**MORTIER**, an ensign of dignity, borne by the chancellor and grand presidents of the parliament of France. That borne by the chancellor is a piece of cloth of gold, edged and turned up with ermine; and that of the first president is a piece of black velvet edged with a double row of gold lace, while that of the other presidents is only edged with a single row. This they formerly carried on their heads, as they still do in grand ceremonies, such as the entry of the king; but ordinarily they carry them in the hand.

**MORTISE**, or **MORTOISE**, in carpentry, &c. a kind of joint wherein a hole of a certain depth is made in a piece of timber, which is to receive another piece called a *tenon*.

**MORTMAIN**, or **ALIENATION in Mortmain**, (*in mortua manu*), is an alienation of lands or tenements to any corporation, sole or aggregate, ecclesiastical or temporal\*: but these purchases having been chiefly made by religious houses, in consequence whereof the lands became perpetually inherent in one dead hand, this hath occasioned the general appellation of *mortmain* to be applied to such alienations, and the religious houses themselves to be principally considered in forming the statutes of mortmain: in deducing the history of which statutes, it will be matter of curiosity to observe the great address and subtle contrivance of the ecclesiastics in eluding from time to time the laws in being, and the zeal with which successive parliaments have pursued them through all their finesses: how new remedies were still the parents of new evasions; till the legislature at last, though with difficulty,

Mortgage  
Mortmain.\* See  
Corporations.

hath

Mortmain. hath obtained a decisive victory.

By the common law any man might dispose of his lands to any other private man at his own discretion, especially when the feudal restraints of alienation were worn away. Yet in consequence of these it was always, and is still necessary, for corporations to have a licence of mortmain from the crown, to enable them to purchase lands: for as the king is the ultimate lord of every fee, he ought not, unless by his own consent, to lose his privilege of escheats and other feudal profits, by the vesting of lands in tenants that can never be attained or die. And such licences of mortmain seem to have been necessary among the Saxons, above 60 years before the Norman conquest. But, besides this general licence from the king as lord paramount of the kingdom, it was also requisite, whenever there was a mesne or intermediate lord between the king and the alienor, to obtain his licence also (upon the same feudal principles) for the alienation of the specific land.

And if no such licence was obtained, the king or other lord might respectively enter on the lands so alienated in mortmain, as a forfeiture. The necessity of this licence from the crown was acknowledged by the constitutions of Clarendon, in respect of advowsons, which the monks always greatly coveted, as being the groundwork of subsequent appropriations. Yet such were the influence and ingenuity of the clergy, that (notwithstanding this fundamental principle) we find that the largest and most considerable dotations of religious houses happened within less than two centuries after the conquest. And (when a licence could not be obtained) their contrivance seems to have been this: That as the forfeiture for such alienations accrued in the first place to the immediate lord of the fee, the tenant who meant to alienate first conveyed his lands to the religious house, and instantly took them back again to hold as tenant to the monastery; which kind of instantaneous feisin was probably held not to occasion any forfeiture: and then, by pretext of some other forfeiture, surrender, or escheat, the society entered into those lands in right of such their newly acquired signiory, as immediate lords of the fee. But when these donations began to grow numerous, it was observed that the feudal services, ordained for the defence of the kingdom, were every day visibly withdrawn; that the circulation of landed property from man to man began to stagnate; and that the lords were curtailed of the fruits of their signiories, their escheats, wardships, reliefs, and the like: and therefore, in order to prevent this, it was ordained by the second of king Henry III.'s great charters, and afterwards by that printed in our common statute-books, that all such attempts should be void, and the land forfeited to the lord of the fee.

But as this prohibition extended only to religious houses, bishops and other fee corporations were not included therein; and the aggregate ecclesiastical bodies (who, Sir Edward Coke observes, in this were to be commended, that they ever had of their counsel the best learned men that they could get) found many means to creep out of this statute, by buying in lands that were *bona fide* holden of themselves as lords of the fee, and thereby evading the forfeiture; or by taking long leases for years, which first introduced those extensive terms, for a thousand or more years, which are now fo

requent in conveyances. This produced the statute *de religiosis*, 7 Edward I.; which provided, that no person, religious or other whatsoever, should buy, or sell, or receive, under pretence of a gift, or term of years, or any other title whatsoever, nor should by any art or ingenuity appropriate to himself any lands or tenements in mortmain; upon pain that the immediate lord of the fee, or, on his default for one year, the lords paramount, and, in default of all of them, the king, might enter thereon as a forfeiture.

This seemed to be a sufficient security against all alienations in mortmain: but as these statutes extended only to gifts and conveyances between the parties, the religious houses now began to set up a fictitious title to the land, which it was intended they should have, and to bring an action to recover it against the tenant; who, by fraud and collusion, made no defence, and thereby judgment was given for the religious house, which then recovered the land by a sentence of law upon a supposed prior title. And thus they had the honour of inventing those fictitious adjudications of right, which are since become the great assurance of the kingdom, under the name of *common recoveries*. But upon this the statute of Westminster the second, 13 Edw. I. c. 32. enacted, that in such cases a jury shall try the true right of the demandants or plaintiffs to the land; and if the religious house or corporation be found to have it, they shall still recover feisin; otherwise it shall be forfeited to the immediate lord of the fee, or else to the next lord, and finally to the king, upon the immediate or other lord's default. And the like provision was made by the succeeding chapter, in case the tenants set up crosses upon their lands (the badges of knights templars and hospitaliers) in order to protect them from the feudal demands of their lords, by virtue of the privileges of those religious and military orders. And so careful was this provident prince to prevent any future evasions, that when the statute of *quia emptores*, 18 Edward I. abolished all sub-infeudations, and gave liberty for all men to alienate their lands to be holden of their next immediate lord, a proviso was inserted that this should not extend to authorise any kind of alienation in mortmain. And when afterwards the method of obtaining the king's licence by writ of *ad quod damnum* was marked out, by the statute 27 Edward I. s. 2. it was farther provided by statute 34 Edward I. s. 3. that no such licence should be effectual without the consent of the mesne or intermediate lords.

Yet still it was found difficult to set bounds to ecclesiastical ingenuity: for when they were driven out of all their former holds, they devised a new method of conveyance, by which the lands were granted, not to themselves directly, but to nominal feoffees to the use of the religious houses; thus distinguishing between the possession and the use, and receiving the actual profits, while the feisin of the land remained in the nominal feoffee; who was held by the courts of equity (then under the direction of the clergy) to be bound in conscience to account to his *cestuy que use* for the rents and emoluments of the estate. And it is to these inventions that our practitioners are indebted for the introduction of uses and trusts, the foundation of modern conveyancing. But, unfortunately for the inventors themselves, they did not long enjoy

Mortmain. enjoy the advantage of their new device; for the statute 15 Richard II. c. 5. enacts, that the lands which had been so purchased to uses should be amortified by licence from the crown, or else be sold to private persons; and that for the future uses shall be subject to the statutes of mortmain, and forfeitable like the lands themselves. And whereas the statutes had been eluded by purchasing large tracts of land adjoining to churches, and consecrating them by the name of *church-yards*, such subtle imagination is also declared to be within the compass of the statutes of mortmain. And civil or lay corporations, as well as ecclesiastical, are also declared to be within the mischief, and of course within the remedy provided by those salutary laws. And, lastly, as during the times of popery lands were frequently given to superstitious uses, though not to any corporate bodies; or were made liable in the hands of heirs and devisees to the charge of obits, chauntries, and the like, which were equally pernicious in a well-governed state as actual alienations in mortmain; therefore at the dawn of the Reformation, the statute 23 Hen. VIII. c. 10. declares, that all future grants of lands for any of the purposes aforesaid, if granted for any longer term than 20 years, shall be void.

But, during all this time, it was in the power of the crown, by granting a licence of mortmain, to remit the forfeiture, so far as related to its own rights; and to enable any spiritual or other corporation to purchase and hold any lands or tenements in perpetuity: which prerogative is declared and confirmed by the statute 18 Edw. III. ft. 3. c. 3. But as doubts were conceived at the time of the Revolution how far such licence was valid, since the king had no power to dispense with the statutes of mortmain by a clause of *non obstant*, which was the usual course, though it seems to have been unnecessary; and as, by the gradual declension of mesne signiories through the long operation of the statute of *quia emptores*, the rights of intermediate lords were reduced to a very small compass; it was therefore provided by the statute 7 & 8 W. III. c. 37. that the crown for the future at its own discretion may grant licences to alien or take in mortmain, of whomsoever the tenements may be held.

After the dissolution of monasteries under H. VIII. though the policy of the next popish successor affected to grant a security to the possessors of abbey-lands, yet, in order to regain so much of them as either the zeal or timidity of their owners might induce them to part with, the statutes of mortmain were suspended for 20 years by the statute 1 & 2 P. & M. c. 8. and during that time any lands or tenements were allowed to be granted to any spiritual corporation without any licence whatsoever. And long afterwards, for a much better purpose, the augmentation of poor livings, it was enacted by the statute 17 Car. II. c. 3. that appropriators may annex the great tithes to the vicarages; and that all benefices under 100 l. *per annum*, may be augmented by the purchase of lands, without licence of mortmain in either case: and the like provision hath been since made, in favour of the governors of queen Anne's bounty. It hath also been held, that the statute 23 Hen. VIII. before-mentioned did not extend to any thing but superstitious uses; and that therefore a man may give lands for the maintenance of a school,

an hospital, or any other charitable uses. But as it was apprehended from recent experience, that persons on their deathbeds might make large and improvident dispositions even for these good purposes, and defeat the political ends of the statutes of mortmain; it is therefore enacted by the statute 9 Geo. II. c. 36. that no lands or tenements, or money to be laid out thereon, shall be given for or charged with any charitable uses whatsoever, unless by deed indented, executed in the presence of two witnesses 12 calendar months before the death of the donor, and enrolled in the court of chancery within six months after its execution, (except stocks in the public funds, which may be transferred within six months previous to the donor's death), and unless such gift be made to take effect immediately, and be without power of revocation: and that all other gifts shall be void. The two universities, their colleges, and the scholars upon the foundation of the colleges of Eton, Winchester, and Westminster, are excepted out of this act: but such exemption was granted with this proviso, that no college shall be at liberty to purchase more advowsons than are equal in number to one moiety of the fellows or students upon the respective foundations.

MORTON (Thomas), a learned English bishop in the 17th century, was bred at St John's college Cambridge, and was logic-lecturer of the university. After several preferments he was advanced to the see of Chester in 1615, and translated to that of Litchfield and Coventry in 1618: at which time he became acquainted with Antonio de Dominis archbishop of Spalatro, whom he endeavoured to dissuade from returning to Rome. While he was bishop of Litchfield and Coventry, in which see he sat 14 years, he educated, ordained, and presented to a living, a youth of excellent parts and memory, who was born blind; and detected the imposture of the famous boy of Bilbon in Staffordshire, who pretended to be possessed with a devil. In 1632 he was translated to the see of Durham, in which he sat with great reputation till the opening of the long parliament, which met in 1640; when he received great insults from the common people, and was committed twice to custody. The parliament, upon the dissolution of bishoprics, voted him 800 l. *per annum*, of which he received but a small part. He died in 1659, in the 95th year of his age and 44th of his episcopal consecration. He published *Apologia Catholica*, and several other works; and was a man of extensive learning, great piety, and temperance.

MORTUARY, in law, is a sort of ecclesiastical heriot\*, being a customary gift claimed by and due to the minister in very many parishes on the death of his parishioners. They seem originally to have been only a voluntary bequest to the church; being intended, as Lyndewode informs us from a constitution of archbishop Langham, as a kind of expiation and amends to the clergy for the personal tithes, and other ecclesiastical duties, which the laity in their life-time might have neglected or forgotten to pay. For this purpose, after the lord's heriot or best good was taken out, the second best chattel was reserved to the church as a mortuary. And therefore in the laws of king Canute this mortuary is called *sul-foot*, or *symbolum anime*. And, in pursuance of the same principle, by the laws of Venice, where no personal tithes have been paid dur-

ring the life of the party, they are paid at his death out of his merchandise, jewels, and other moveables. So also, by a similar policy, in France, every man that died without bequeathing a part of his estate to the church, which was called *dying without confession*, was formerly deprived of Christian burial: or, if he died intestate, the relations of the deceased, jointly with the bishop, named proper arbitrators to determine what he ought to have given to the church, in case he had made a will. But the parliament, in 1409, redressed this grievance.

It was anciently usual in England to bring the mortuary to church along with the corpse when it came to be buried; and thence it is sometimes called a *corse-present*: a term which bespeaks it to have been once a voluntary donation. However, in Bracton's time, so early as Henry III. we find it rivetted into an established custom: inasmuch that the bequests of heriots and mortuaries were held to be necessary ingredients in every testament of chattels. *In primis autem debet quilibet, qui testamentum fecerit, dominum suum de meliori re quam habuerit recognoscere; et postea ecclesiam de alia meliori*: the lord must have the best good left him as an heriot; and the church the second best as a mortuary. But yet this custom was different in different places: *in quibusdam locis habet ecclesia melius animal de consuetudine; in quibusdam secundum, vel tertium melius; et in quibusdam nihil: et ideo consideranda est consuetudo loci*. This custom still varies in different places, not only as to the mortuary to be paid, but the person to whom it is payable. In Wales a mortuary or corse-present was due upon the death of every clergyman to the bishop of the diocese; till abolished, upon a recompence given to the bishop, by the statute 12 Ann. st. 2. c. 6. And in the archdeaconry of Chester a custom also prevailed, that the bishop, who is also archdeacon, should have, at the death of every clergyman dying therein, his best horse or mare, bridle, saddle, and spurs, his best gown or cloak, hat, upper garment under his gown, and tippet, and also his best signet or ring. But by statute 28 Geo. II. c. 6. this mortuary is directed to cease, and the act has settled upon the bishop an equivalent in its room. The king's claim to many goods, on the death of all prelates in England, seems to be of the same nature; though Sir Edward Coke apprehends, that this is a duty upon death, and not a mortuary: a distinction which seems to be without a difference. For not only the king's ecclesiastical character, as supreme ordinary, but also the species of the goods claimed, which bear so near a resemblance to those in the archdeaconry of Chester, which was an acknowledged mortuary, puts the matter out of dispute. The king, according to the record vouched by Sir Edward Coke, is entitled to six things; the bishop's best horse or palfrey, with his furniture; his cloak or gown, and tippet; his cup and cover; his hagon and ewer; his gold ring; and lastly, his *nuta canum*, his mew or kennel of hounds.

This variety of customs with regard to mortuaries, giving frequently a handle to exactions on the one side, and frauds or expensive litigations on the other, it was thought proper by statute 21 Henry VIII. c. 6. to reduce them to some kind of certainty. For this purpose it is enacted, that all mortuaries, or corse-presents to parsons of any parish, shall be taken in the

following manner, unless where by custom less or none at all is due: *viz.* for every person who does not leave goods to the value of ten marks, nothing: for every person who leaves goods to the value of ten marks and under 30 pounds, 3s. 4d. if above 30 pounds, and under 40 pounds, 6s. 8d. if above 40 pounds, of what value soever they may be, 10s. and no more. And no mortuary shall throughout the kingdom be paid for the death of any feme covert; nor for any child; nor for any one of full age, that is not a housekeeper; nor for any wayfaring man; but such wayfaring man's mortuary shall be paid in the parish to which he belongs. And upon this statute stands the law of mortuaries to this day.

MORUS, the MULBERRY-TREE; a genus of the tetrandria order, belonging to the monœcia class of plants. The most remarkable species are,

1. The *nigra*, or common black-fruited mulberry-tree. It rises with an upright, large, rough trunk, dividing into a large, branchy, and very spreading head, rising 20 feet high, or more; large, heart-shaped, rough leaves, and monœcious flowers; succeeded in the females by large succulent black-berries. There is a variety with jagged leaves and smaller fruit. This species is the proper mulberry-tree for general cultivation in this country for its fruit; the tree being a plentiful bearer, and the fruit ripen in good perfection in August and September.

2. The *alba*, or white mulberry-tree, rises with an upright trunk, branching 20 or 30 feet high; garnished with large, oblique, heart-shaped, smooth, light-green, shining leaves, and monœcious flowers, succeeded by pale-whitish fruit. There is a variety with purplish fruit.

3. The *papyrifera*, or paper mulberry-tree of Japan, grows 20 or 30 feet high, with large palmated leaves, some trilobate, others singlelobed, and monœcious flowers, succeeded by small black fruit. In the countries where this tree grows naturally, the inhabitants make paper of the bark.

4. The *rubra*, or red Virginia mulberry-tree, grows 30 feet high, with very large, heart-shaped, rough leaves, hairy underneath, and monœcious flowers, succeeded by large reddish berries.

All these trees are very hardy, and succeed in any common soil and situation. The black mulberry is the only sort proper to cultivate as a fruit-tree for its fruit; the others are principally employed here to form variety in our ornamental plantations, of which the white and paper mulberry are the most common, the red sort being very scarce in the English gardens; the black and the white-fruited kinds are also eminent for their leaves to feed silk-worms, they being the principal food of these valuable insects; but the white mulberry-leaves are in the most esteem for this purpose; and abroad, in France, Italy, &c. vast plantations of the trees are made solely for their leaves to feed silk-worms, which amply reward the possessors with the annual supply of silk they spin from their bowels: plantations of the same trees has formerly been recommended in this country for the purpose of silk-worms, to introduce the manufacturing of raw silk, since it is observable that where the trees thrive, the silk-worms will also prosper; all recommendations, however, have proved fruitless, although

Mosaic. it in time might probably turn to a national advantage.

The leaves of these trees are generally late before they begin to come out, the buds seldom beginning to open till the middle or towards the latter end of May, according to the temperature of the season; and when these trees in particular begin to expand their foliage, it is a good sign of the near approach of fine warm settled weather; the white mulberry, however, is generally forwarder in leafing than the black.

The flowers and fruit come out soon after the leaves; the males in *amentanus*, and the females in small roundish heads; neither of which are very conspicuous, nor possess any beauty, but for observation; the female or fruitful flowers always rise on the extremity of the young shoots, on short spurs; and with this singularity, the calices of the flowers become the fruit; which is of the berry kind, and being composed of many tubercles, each of these furnish one seed. The fruit ripens here gradually from about the middle of August until the middle of September; which in dry warm seasons ripen in great perfection; but when it proves very wet weather they ripen but indifferently, and prove devoid of flavour.

Considered as fruit-trees, the black-fruited kind is the only proper sort to cultivate, the trees being not only the most plentiful bearers in this country, but the fruit are larger and much finer-flavoured than the white kind, which is the only sort, besides the black mulberry, that bears fruit in this country.

MOSAIC, or MOSAIC-WORK, an assemblage of little pieces of glass, marble, precious stones, &c. of various colours, cut square, and cemented on a ground of stucco, in such a manner as to imitate the colours and gradations of painting. The critics are divided as to the origin and reason of the name. Some derive it from *mosaicum*, a corruption of *musaicum*, as that is of *musæum*, as it was called among the Romans. Scaliger derives it from the Greek *μουσα*, and imagines the name was given to this sort of works as being very fine and ingenious. Nebricenfis is of opinion it was so called, because *ex illis picturis ornabantur musæa*.

1. Method of performing Mosaic-work of *glass* is this: They provide little pieces of glass, of as many different colours and sizes as possible.

Now, in order to apply these several pieces, and out of them to form a picture, they in the first place procure a cartoon or design to be drawn; this is transferred to the ground or plaster by calking, as in painting in fresco. See *Fresco*.

As this plaster is to be laid thick on the wall, and therefore will continue fresh and soft a considerable time, so there may be enough prepared at once to serve for as much work as will take up three or four days.

This plaster is composed of lime, made of hard stone, with brick-dust very fine, gum tragacanth, and whites of eggs: when this plaster has been thus prepared and laid on the wall, and made the design of what is to be represented, they take out the little pieces of glass with a pair of pliers, and range them one after another, still keeping strictly to the light, shadow, different tints, and colours, represented in the design before; pressing or flattening them down with a

ruler, which serves both to sink them within the ground, and to render the surface even.

Thus in a long time, and with a great deal of labour, they finish the work, which is still the more beautiful, as the pieces of glass are more uniform, and ranged at an even height.

Some of these pieces of mosaic-work are performed with that exactness, that they appear as smooth as a table of marble, and as finished and masterly as a painting in fresco; with this advantage, that they have a fine lustre, and will last ages.

The finest works of this kind that have remained till our time, and those by whom the moderns have retrieved the art, which was in a manner lost, are those in the church of St Agnes, formerly the temple of Bacchus, at Rome; and some at Pisa, Florence, and other cities of Italy. The most esteemed among the works of the moderns are those of Joseph Pine and the Chevalier Lanfranc, in the church of St Peter at Rome: there are also very good ones at Venice.

2. Method of performing Mosaic-work of *marble* and *precious stones* is this: The ground of Mosaic-works, wholly marble, is usually a massive marble, either white or black. On this ground the design is cut with a chisel, after it has been first calked. After it has been cut of a considerable depth, *i. e.* an inch or more, the cavities are filled up with marble of a proper colour, first fashioned according to the design, and reduced to the thickness of the indentures with various instruments. To make the piece thus inserted into the indentures cleave fast, whose several colours are to imitate those of the design, they use a stucco, composed of lime and marbledust; or a kind of mastic, which is prepared by each workman, after a different manner peculiar to himself.

The figures being marked out, the painter or sculptor himself draws with a pencil the colours of the figures not determined by the ground, and in the same manner makes strokes or hatchings in the place where shadows are to be: and after he has engraven with the chisel all the strokes thus drawn, he fills them up with a black mastic, composed partly of Burgundy-pitch poured on hot; taking off afterwards what is superfluous with a piece of soft stone or brick, which, together with water and beaten cement, takes away the mastic, polishes the marble, and renders the whole so even that one would imagine it only consisted of one piece.

This is the kind of Mosaic-work that is seen in the pompous church of the invalids at Paris, and the fine chapel at Versailles, with which some entire apartments of that palace are incrustated.

As for Mosaic-work of precious stones, other and finer instruments are required than those used in marble; as drills, wheels, &c. used by lapidaries and engravers on stone. As none but the richest marbles and stones enter this work, to make them go the farther, they are sawn into the thinnest leaves imaginable, scarce exceeding half a line in thickness; the block to be sawn is fastened firmly with cords on the bench, and only raised a little on a piece of wood, one or two inches high. Two iron pins, which are on one side the block, and which serve to fasten it, are put into a vice

Mosaic.

contrived for the purpose; and with a kind of saw or bow, made of fine brads-wire, bent on a piece of spongy wood, together with emery steeped in water, the leaf is gradually fashioned by following the stroke of the design, made on paper, and glued on the piece. When there are pieces enough fastened to form an entire flower, or some other part of the design, they are applied to the ground.

The ground which supports this Mosaic-work is usually of free-stone. The matter with which the stones are joined together, is a mastic, or kind of stucco, laid very thin on the leaves as they are fashioned; and this being done, the leaves are applied with plecters.

If any contour, or side of a leaf, be not either squared or rounded sufficiently, so as to fit the place exactly into which it is to be inserted, when it is too large, it is to be brought down with a brads file or rasp; and if it be too little, it is managed with a drill and other instruments used by lapidaries.

Mosaic-work of marble is used in large works, as in pavements of churches, basilics, and palaces; and in the incrustation and vanecring of the walls of the same edifices.

As for that of precious stones, it is only used in small works, as ornaments for altar-pieces, tables for rich cabinets, precious stones being so very dear.

3. Manner of performing Mosaic-work of *gypsum*. Of this stone calcined in a kiln, beaten in a mortar, and sifted, the French workmen make a sort of artificial marbles, imitating precious stones; and of these they compose a kind of Mosaic-work, which does not come far short either of the durability or the vivacity of the natural stones; and which besides has this advantage, that it admits of continued pieces or paintings of entire compartments without any visible joining.

Some make the ground of plaster of Paris, others of free stone. If it be of plaster of Paris, they spread it in a wooden frame, of the length and breadth of the work intended, and in thickness about an inch and a half. This frame is so contrived, that the tenons being only joined to the mortises by single pins, they may be taken asunder, and the frame be dismounted, when the plaster is dry. The frame is covered on one side with a strong linen-cloth, nailed all round, which being placed horizontally with the linen at the bottom, is filled with plaster passed through a wide sieve. When the plaster is half dry, the frame is set up perpendicularly, and left till it is quite dry; then it is taken out, by taking the frame to pieces.

In this mosaic, the ground is the most important part. Now in order to the preparation of this sifted gypsum, which is to be applied on this ground, it is dissolved and boiled in the best English glue, and mixed with the colour that it is to be of; then the whole is worked up together into the usual consistence of plaster, and then is taken and spread on the ground five or six inches thick. If the work be such, as that mouldings are required, they are formed with gouges and other instruments.

It is on this plaster, thus coloured like marble or precious stone, and which is to serve as a ground to a work, either of lapis, agate, alabaster, or the like, that the design to be represented is drawn; having

been first pounced or calqued. To hollow or impress the design, they use the same instruments that sculptors do; the ground whereon they are to work not being much less hard than the marble itself. The cavities being thus made in the ground, are filled with the same gypsum boiled in glue, only differently coloured, and thus are the different colours of the original represented. In order that the necessary colours and tints may be ready at hand, the quantities of the gypsum are tempered with the several colours in pots.

After the design has been thus filled and rendered visible, by half-polishing it with brick and soft stone, they go over it again, cutting such plates as are either to be weaker or more shadowed, and filling them with gypsum; which work they repeat, till all the colours being added one after the other, represent the original to the life.

When the work is finished, they scour it with soft stone, sand, and water; after that, with a pumice-stone; and in the last place polish it with a wooden muller and emery. Then, lastly, they gave it a lustre, by smearing it over with oil, and rubbing it a long time with the palm of the hand, which gives it a lustre no ways inferior to that of natural marble.

MOSAMBIQUE, a kingdom of Africa, lying fourth of Quiloa, and taking its name from the chief town, which is situated on an island, at the mouth of a river of the same name, in 15° S. Lat. The island is thirty miles in circumference, and very populous, though the air is said to be very hot, and the soil in general dry, sandy, and barren; yet they have most of the tropical fruits, with black cattle, hogs, and sheep. There is a kind of fowl here, both the feathers and flesh of which are black, inasmuch that, when they are boiled, the broth looks like ink; and yet their flesh is very delicate, and good food. The town of Mosambique is regularly fortified, and has a good harbour, defended by a citadel, with several churches and monasteries. The Portuguese shipping to and from India touch here for refreshments. As the island abounds in cattle, the Portuguese slaughter and salt up a great deal of beef, which they afterwards send to the Brasils, or sell to the European shipping. They also barter European goods with the natives for gold, elephants teeth, and slaves. There is another town, called *Mongale*, situated also on an island, and garrisoned by the Portuguese, being their chief magazine for European goods. The gold they receive from the natives is found near the surface of the earth, or in the sands of rivers; no gold-mines, or at least very few, being at present wrought in Africa.

MOSCHUS, a Grecian poet of antiquity, usually coupled with Bion; and they were both of them contemporaries with Theocritus. In the time of the latter Grecians, all the ancient Idylliums were collected and attributed to Theocritus; but the claims of Moschus and Bion have been admitted to some few little pieces; and this is sufficient to make us inquisitive about their characters and story; yet all that can be known about them must be collected from their own remains. Moschus, by composing his delicate elegy on Bion, has given the best memorials of Bion's life. See Bion. Moschus and Theocritus have by some critics been supposed the same person; but there are irrefragable evidences against it: others will have him

Mofambique,  
Moschus.

Moschus. as well as Bion to have lived later than Theocritus, upon the authority of Suidas; while others again suppose him to have been the scholar of Bion, and probably his successor in governing the poetic school; which, from the elegy of Moschus, does not seem unlikely. Their remains are to be found in all the editions of the Poetæ minores.

Moschus, in zoology, a genus of quadrupeds of the order of pecora, having no horns; the canine teeth of the upper jaw are solitary and exerted. There are three species.

1. The Moschiferus, or musk animal, hath been considered by some authors as a stag, a roebuck, a goat; and by others as a large cherrontain, a species of antelope; but M. Buffon hath determined it to be an ambiguous animal, participating of the nature of all these, but differing essentially from every one of them, and from all other animals. It is of the size of a small roebuck, but has no horns; it has long coarse hair, a sharp muzzle, and tusks like those of the hog. From the nose to the tail, the animal is about a yard and half a foot long; the head above half a foot; the neck is a quarter of a yard, the fore-head three inches broad; the nose end scarce three-fourths of an inch, being very sharp, like that of a greyhound. The ears are like those of a rabbit, about three inches long, and erect; as is also the tail, which exceeds not two inches; the fore-legs are a foot and two inches long, taking in the foot and thigh. The foot is deeply cloven; with two fore-hoofs, an inch and a quarter long, each a quarter of an inch over; and two heels almost as big, and therefore conspicuous. The hair on the head and legs is about half an inch long, and rateably small; on the belly it is an inch and an half in length, and somewhat thicker; on the back and buttocks it is three inches long, thicker in proportion than in any other animal, excepting perhaps some of the deer-kind, viz. three or four times as thick as hog's bristles; consisting of brown and white portions alternately from the root to the top. On the head and legs it is brown; on the belly, and under the tail, whitish, and as it were frizzled, especially on the back and belly, by a kind of undulation. The hair of the musk is softer than in most animals, and exceeding light and rare; for, being split, they appear to be made up of little bladders, like those in the plume or stalk of a quill; so that it is something betwixt a common hair and a quill. On each side of his lower chop, almost under the corner of his mouth, there is a peculiar tuft, (about three-fourths of an inch long), of short, thick, and hard hairs, or rather bristles, of equal length, as in a scrubbing-brush. The musk-bladder or bag which holds the perfume, is on the belly near the navel. It is about three inches long, and two over; standing out from the belly one and a half, and before the groin as much. The creature hath 26 teeth, 16 in the lower chop; of which there are eight little cutters before; behind four grinders on each side, rugged and continuous, with as many grinders in the upper jaw. About an inch and an half from the nose end in the same jaw, is on each side a tusk two inches and an half long, hooked downward and backward, and ending in a point. This tusk is not round, but flat; the breadth of half an inch; thin, and having a sharp edge behind; so that it hath

a considerable resemblance of a scythe.—From the testimony of a number of travellers it appears that the perfume is produced only in the body of the male. The female hath indeed a pouch of the same kind near the navel, but the humour secreted in it has not the same odour; and this tumour of the male is not filled with musk except in the rutting season; at other times the quantity of this humour is smaller, and its odour weaker. See MUSK.

2. The grimmia, grimm, or Guinea antelope, is a most beautiful animal, with frait black horns, slender and sharp-pointed, not three inches long, and slightly annulated at the base. Its height is about 18 inches; the ears are large, and the eyes dusky; below the eyes is a large cavity, into which exudes a strong-scented oily liquid; between the horns is a tuft of black hairs. The colour of the neck and body is brown, mixed with an ash-colour, and a tinge of yellow; the belly is white; the tail short, white beneath, and black above. M. Vofmaer tells us, that these animals are extremely timid, and easily frightened with any noise, particularly thunder; when surprised, they express their fear by blowing suddenly and with great force through their noses. He describes one which was kept in the menagerie of the prince of Orange. "This one (says he) was at first wild, but afterwards became pretty tame. It listens when called by its name *Tetje*; and when gently approached with a piece of bread in the hand, it allows its head and neck to be stroaked. It is so cleanly, that it suffers not the smallest particle of dirt to remain on any part of its body; and for this purpose it often scratches itself with one of its hind-feet. This is the reason why it has received the appellation of *tetje*, from *tettig*, which signifies neat or clean. However, if a person continues for some time to rub its body, a white powder adheres to his fingers like that which proceeds from horses when they are curried. This animal is extremely agile; and, when reposing, it frequently keeps one of its fore-feet in an elevated and beaded position, which gives it a very agreeable appearance. It is fed with bread, rye, and carrots: it likewise spontaneously eats potatoes: it is a ruminating animal, and discharges its excrements in small balls, the size of which is considerable in proportion to the magnitude of the creature."—Dr Herman Grimm tells us, that the fat, viscid, yellow humour, which is secreted in the cavities above the eyes of this animal, has an odour that participates of musk and castoreum; but M. Vofmaer remarks, that in his live subject this viscid matter has no odour of any kind.

3. The pygmaeus has feet narrower than a man's finger, and is found in Africa and Asia.

MOSCOW, the chief province of the empire of Russia, deriving its name from the river Muscova, or Moskva, on which the capital is situated. It was from this duchy that the czars of old took the title of *dukes of Muscovy*. The province is bounded on the north by the duchies of Twer, Rostow, Sudal, and Wodjimer; on the south by Rezan, from which it is separated by the river Oeca; on the east by the principality of Cachine, and the same river Oeca parting it from Nili-novogorod; and on the west by the duchies of Rzeva, Biela, and Smolesko. It extends about 200 miles in length, and about 100 in breadth; and

Moschus.  
Moscow.

Plate  
CLXXXII.  
fig. 2.

Moscow is watered by the Moskva, Occa, and Clefma, which fall into the Wolga: nevertheless, the soil is not very fertile. The air, however, though sharp, is salubrious; and this consideration, with the advantage of its being situated in the midst of the best provinces in the empire, induced the czars to make it their chief residence. In the western part of Moscow is a large forest, from whence flows the celebrated river Nieper, or Borysthenes, which, traversing the duchy of Smolensko, winds in a serpentine course to Ukraina, Lithuania, and Poland. The capital, Moscow, or Moskova, is the metropolis and largest city of the Russian empire, situated in a spacious plain on the banks of the river Moskva; over which the prince Gasifchin built a stately bridge, consisting of 12 arches of prodigious height, breadth, and solidity, because the river is so apt to overflow its banks: it was designed by a Polish monk, and is the only stone-bridge in all Russia. Moscow is seated on a wholesome gravelly soil, and divided into four quarters, each surrounded with a distinct wall. These districts are known by the names of *Cataigorod*, *Czarigorod*, *Skorodum*, and *Strelitze-flaboda*. The *Cataigorod*, surrounded with a brick-wall, is the middle of the city; in which stands the citadel, about two miles in circuit, fortified with a triple wall, flanked with towers and a fosse. It contains two imperial palaces, the one of timber and the other of stone, built after the Italian architecture; the patriarchal palace, which is a large ancient edifice; the exchequer, chancery, and other offices; two noble monasteries; five large churches, including that of St Michael, famous for its fabric and ornaments, as well as for the monuments of the grand dukes and czars who have been here interred; the grand magazine, and many other stately buildings. Without the citadel-gate stands that noble edifice the church of Jerusalem, finished by the czar John Basilides, who ordered the architect to be deprived of his eye-sight, that he might never contrive, or at least behold, its equal. In the great market that fronts the citadel we see the stupendous bell, supposed to be the largest in the whole world. It was hung in a tower built for the purpose, which tower was consumed by fire in the beginning of the present century. The weight of the bell amounts to 336,000 pounds. It is in height 19 feet, in diameter 23, in circumference 70, and the sides are two feet in thickness. One hundred men were employed in moving this monstrous machine, which was only rung on extraordinary occasions: for example, when the Czar condescended to shew himself to his people, and when he conversed with his wife, that the subjects might know when to petition heaven that a male child should be the issue of the conjugal embrace. This district is watered by the rivers *Negliza* and *Moska*; and is called *Cataigorod*, from *catai*, the Russian name for China, because here the merchandises of that empire are chiefly sold. The *Czarogorod*, or ducal city, encompassed the *Cataigorod*, and is itself fortified with a white-stone wall, called *Bielasjena*; whence it has acquired the appellation of *Bielagorod*, or the *white city*. The most remarkable building in this division is the great arsenal. The *Skorodum* quarter stands to the north-west of the *Czarogorod*; and is chiefly inhabited by timber-merchants and carpenters, who sell wooden houses ready made. It is surrounded

with a mud-wall, and distinguished by the name of *Skorodum*, which signifies *done in haste*; because, on an alarm from the Tartars, it was finished in four days, tho' it is 15 miles in circuit, and the earth is every where supported by planks and beams of timber. It is absolutely necessary that there should be such a magazine of houses ready made, to supply the loss of those that perish almost every day by conflagrations, owing to the carelessness, rage, and intoxication, of the inhabitants. On the east and south-east sides of the *Cataigorod* and citadel stands the *Strelitze-flabodo*, so called from the guards of that name, who were formerly lodged in this quarter, which is fortified with wooden ramparts, and divided from the other parts of the city by the river Moskva. The houses of the commonalty are no better than mean pauntry wooden huts, without neatness and furniture: but the merchants secure their commodities in vaults of stone or brick, which are proof against the accidents of fire. There are 3000 stone or brick houses in the city of Moscow; but they stand at such distances from one another, are so intermingled with rows of wooden houses, and such a number of them stand detached from, and as it were behind the streets, surrounded with high walls, that the effect of them is almost lost in the general prospect. The streets, instead of being paved with stones, are boarded with fir-planks; so that in conflagrations the ground seems to burn, and it becomes impossible to approach the scene of disaster. Among the churches and chapels of this city, which are said to amount in number to 1500, that in the Krimelin, or palace of the citadel, is a very ancient and remarkable edifice. On the right-hand side of the altar is the Czar's throne, and on the left is that of the patriarch. The body of the church is lighted by a silver chandelier of immense weight and value. The jewels and ornaments belonging to an image of the Virgin Mary are valued at half a tun weight in gold: but inestimable is the value of an infinite number of chalices, pixes, patens, statues, and other church-utensils of gold and silver, curiously wrought and enriched with precious stones, a prodigious number of rich priestly vestments, besides innumerable donatives, and presents offered to the relics of three eminent Russian saints interred in this place. In a word, the treasure contained in this church is said to equal, at least, that of any cathedral in Europe. Hard by the church of St Michael, which we have mentioned above, is the stately abbey of nuns, called *tzudoff-monaster*: here the bodies of the princesses of the blood are interred; and in a separate chapel we see the tombs of those princes who never ascended the throne. Nothing can be more rich and magnificent than the palls with which their coffins are covered on holidays. Of the several monasteries that appear in Moscow and its neighbourhood, the most remarkable is the *Dewitz-monaster*, about a mile from the city, where Peter confined his ambitious sister the princess Sophia, who had hatched so many conspiracies against his government. This monastery, which is situated in an extensive plain, contains 300 nuns, who are kept under severe restrictions, contrary to the freedom with which other Muscovite nuns are indulged. The only liberty these enjoy is in holiday-time, when they are permitted to walk on the terraces of the garden, which over-



look the adjacent plain.

Peter the Great founded at Moscow three colleges, and selected for them able professors. In the first they taught humanity, rhetoric, and philosophy; in the second, mathematics; and in the third, navigation and astronomy. To these colleges he added a dispensary, which is one of the noblest structures in Moscow, completely furnished with all sorts of drugs and medicines, under the care of some Germans well skilled in the art of pharmacy and chemistry. The yearly revenue of this dispensary amounts to 2000 rubles, allotted for fresh supplies of the *materia medica*; and from hence not only the army, but likewise all the chief cities of the empire, are furnished.

The courts of judicature, custom-house, goals, and other public edifices, are built of stone, large, strong, and massy. The city of Moscow was founded in the year 1334, and in process of time gradually enlarged itself to such a degree, that it is said to have contained 80,000 houses: but in the sequel it suffered greatly, both from the enemy and successive conflagrations. Nevertheless, in the reign of Charles II. of England, while lord Carlisle was ambassador at that court, the city was 12 miles in compass, and the number of houses computed at 40,000. Notwithstanding the severity and vigilance of the magistracy in Moscow, the city swarms with sturdy-beggars and vagabonds, who render it very unsafe to walk through the streets in the dark. Some of these, being armed with short truncheons, lurk in obscure corners, from whence they throw their weapons at the heads of passengers with such dexterity that they seldom fail to knock them down: then they rob and murder them, and make off with the booty. The body of the person thus murdered is exposed in public for a certain time; and, if not owned, the magistrates order it to be thrown into a large deep pit, dug on purpose for the interment of all those who lose their lives in this manner: thither some priests repair on Whitstide-holidays, to say mass for the souls of the deceased. The ancient splendour and opulence of Moscow was greatly diminished by the building of Petersburg, and the removal of the court to that city. Nevertheless the place is still populous; and there is plenty of all kinds of provision, extremely good, and surprisingly cheap; except the article of fish, for which there is a very great demand, occasioned by the four great lent and weekly fasts observed by the Russians. The canal between Moscow and Petersburg is one of the most stupendous works of the czar Peter: it begins at the Nieva, and is continued from lake to lake, and river to river, for near 100 leagues, until it reaches Moscow. What is properly deemed the artificial canal, commences at the city of Novogorod, and is carried on with incredible labour and expence through the territories of Brognitz, Christitz, Chilolova, Witichora, Voloscha, Torfchock, the province of Twere, and the district of Kila. The city of Moscow stands about 650 miles from Kisa, the capital of Crim-Tartary; 950 miles from Constantinople; 720 from Cracow in Poland; 660 from Stockholm; and 1320 from London; in 55 degrees 42 minutes of north latitude.

MOSELLE, a river of Germany, which rises in the mountains of Vauge in Lorrain, and, running thro' that duchy and the electorate of Triers, falls into the

Rhine at Coblentz.

MOSÉS, the great prophet and lawgiver of the Jews, son of Amram, was born *anno mundi* 2423, and died without sickness, *anno mundi* 2553, aged 120.—He wrote the Pentateuch, and the book of Job is attributed to him.

MOSKITO COUNTRY, is situated in North America, between 85 and 88 degrees of west longitude, and between 13 and 15 degrees of north latitude; having the north sea on the north and east; Nicaragua on the south; and Honduras on the west; and indeed the Spaniards esteem it a part of the principality of Honduras, though they have no colonies in the Moskito country. When the Spaniards first invaded this part of Mexico, they massacred the greatest part of the natives, which gave those that escaped into the inaccessible part of the country an unsuperable aversion to them; and they have always appeared ready to join any Europeans that come upon their coasts against the Spaniards, and particularly the English, who frequently come hither; and the Moskito-men being excellent marksmen, the English employ them in striking the marate fish, &c. and many of the Moskito Indians come to Jamaica, and sail with the English in their voyages.

These people are so situated between morasses and inaccessible mountains, and a coast full of rocks and shoals, that no attempts against them by the Spaniards, whom they mortally hate, could ever succeed. Nevertheless, they are a mild inoffensive people, of great morality and virtue, and will never trust a man who has once deceived them. They have so great a veneration towards the English, that they have spontaneously put themselves and their lands under the protection and dominion of the crown of England. This was first done when the duke of Albemarle was governor of Jamaica, and the king of the Moskitos received a commission from his grace, under the seal of that island; since which time, they have not only been steady in their alliance with the English, but warm in their affections, and very useful to them on many occasions.

When their king dies, the next male heir goes to Jamaica, to certify that he is next in blood; and receives a commission in form from the governor of Jamaica to be king of the Moskitos, till which he is not acknowledged as such by his countrymen. So fond are these people of every thing that is English, that the common people are proud of every Christian or surname given them by our seamen, who honour their chief men with the titles of some of our nobility.

MOSQUE, a temple or place of religious worship among the Mahometans.

All mosques are square buildings, generally constructed of stone. Before the chief gate there is a square court paved with white marble; and low galleries round it, whose roof is supported by marble pillars. In these galleries the Turks wash themselves before they go into the mosque. In each mosque there is a great number of lamps; and between these hang many crystal rings, ostriches eggs, and other curiosities, which, when the lamps are lighted, make a fine shew. As it is not lawful to enter the mosque with stockings or shoes on, the pavements are covered with pieces of stuff sewed together, each being wide enough

Mosé  
Mosque.

Mosq.  
Mosques.

to hold a row of men kneeling, sitting, or prostrate. The women are not allowed to enter the mosque, but stay in the porches without. About every mosque there are six high towers, called *minarets*, each of which has three little open galleries, one above another: these towers, as well as the mosques, are covered with lead, and adorned with gilding and other ornaments; and from thence, instead of a bell, the people are called to prayers by certain officers appointed for that purpose. Most of the mosques have a kind of hospital belonging to them, in which travellers, of what religion soever, are entertained three days. Each mosque has also a place called *tarbe*, which is the burying-place of its founders; within which is a tomb six or seven feet long, covered with green velvet or fawn; at the ends of which are two tapers, and round it several seats for those who read the koran, and pray for the souls of the deceased.

MOSS (Robert), dean of Ely, was bred in Bennet-college Cambridge, of which he was chosen a fellow. He acquired the reputation of one of the most ingenious performers of any about his time, of all kinds of public exercises, whether in classical or academical learning. His sermons at St Mary's were much crowded. He published sermons, and some poems: and he is supposed to be the author of a pamphlet intitled, *A defence of my lords the bishops, as well as the clergy of the lower house of Convocation; in a letter from a member of that house to the prolocutor, concerning the late consultations about the bishop of Bangor's writings*. He died in 1729, aged 63.

MOSESSE, in botany. See MUSCI.

Colours extracted from MOSESSE. See COLOUR-Making, n<sup>o</sup> 38.

Moss is also a name given by some to the boggy ground in many parts of England, more usually called a *fen* and *bog*.

In many of these grounds, as well in England and Ireland as in other parts of the world, there are found vast numbers of trees standing with their stumps erect, and their roots piercing the ground in a natural posture, as when growing. Many of those trees are broken or cut off near the roots, and lie along, and this usually in a north-east direction. People who have been willing to account for this, have usually resolved it into the effect of the deluge in the days of Noah; but this is a very wild conjecture, and is proved false by many unanswerable arguments. The waters of this deluge might indeed have washed together a great number of trees, and buried them under loads of earth; but then they would have lain irregularly and at random; whereas they all lie lengthwise from south-west to north-east, and the roots all stand in their natural perpendicular posture, as close as the roots of trees in a forest.

Beside, these trees are not all in their natural state, but many of them have the evident marks of human workmanship upon them, some being cut down with an ax, some split, and the wedges still remaining in them; some burnt in different parts, and some bored through with holes. These things are also proved to be of a later date than the deluge, by other matters found among them, such as utensils of ancient people, and coins of the Roman emperors.

It appears from the whole, that all the trees which

we find in this fossil state, originally grew in the very places where we now find them, and have only been thrown down and buried there, not brought from elsewhere. It may appear indeed an objection to this opinion, that most of these fossil trees are of the fir kind; and that Cæsar says expressly, that no fir grew in Britain in his time: but this is easily answered by observing, that these trees, though of the fir kind, yet are not the species usually called the *fir*, but pitch-tree; and Cæsar has no where said that pitch-trees did not grow in England. Norway and Sweden yet abound with these trees; and there are at this time whole forests of them in many parts of Scotland, and a large number of them wild upon a hill at Wareton in Staffordshire to this day.

In Hatfield marsh, where such vast numbers of the fossil trees are now found, there has evidently once been a whole forest of them growing. The last of these was found alive, and growing in that place within 70 years last past, and cut down for some common use.

It is also objected by some to the system of the firs growing where they are found fossil, that these countries are all bogs and moors, whereas these sorts of trees grow only in mountainous places. But this is founded on an error; for though in Norway and Sweden, and some other cold countries, the fir-kinds all grow upon barren and dry rocky mountains, yet in warmer places they are found to thrive as well on wet plains. Such are found plentifully in Pomerania, Livonia, and Courland, &c. and in the west parts of New England there are vast numbers of fine stately trees of them in low grounds. The whole truth seems to be, that these trees love a sandy soil; and such is found at the bottoms of all the mosses where these trees are found fossil. The roots of the fir-kind are always found fixed in these; and those of oaks, where they are found fossil in this manner, are usually found fixed in clay: so that each kind of tree is always found rooted in the places where they stand in their proper soil; and there is no doubt to be made, but that they originally grew there. When we have thus found that all the fossil trees we meet with once grew in the places where they are now buried, it is plain that in these places there were once noble forests, which have been destroyed at some time; and the question only remains how and by whom they were destroyed. This we have reason to believe, by the Roman coins found among them, was done by the people of that empire, and that at the time when they were established, or establishing, themselves here.

Their own historians tells us, that when their armies pursued the wild Britons, these people always sheltered themselves in the miry woods, and low watery forests. Cæsar expressly says this; and observes, that Cassibelan and his Britons, after their defeat, passed the Thames, and fled into such low morasses and woods, that there was no pursuing them: and we find that the Silures secured themselves in the same manner when attacked by Olorius and Agricola. The same thing is recorded of Venutius king of the Brigantes, who fled to secure himself into the boggy forests of the midland part of this kingdom: and Herodian expressly says, that in the time of the Romans pursuing their conquests in these islands, it was the custom

Mosq.

Moss. fion of the Britons to secure themselves in the thick forests which grew in their boggy and wet places, and when opportunity offered, to issue out thence and fall upon the Romans. The consequence of all this was the destroying all these forests; the Romans finding themselves plagued with parties of the natives issuing out upon them at times from these forests, that they gave orders for the cutting down and destroying all the forests in Britain which grew on boggy and wet grounds. These orders were punctually executed; and to this it is owing that at this day we can hardly be brought to believe that such forests ever grew with us as are now found buried.

The Roman histories all join in telling us, that when Suetonius Paulinus conquered Anglesea, he ordered all the woods to be cut down there, in the manner of the Roman generals in England: and Galen tells us, that the Romans, after their conquest in Britain, kept their soldiers constantly employed in cutting down forests, draining of marshes, and paving of bogs. Not only the Roman soldiers were employed in this manner, but all the native Britons made captives in the wars were obliged to assist in it: and Dion Cassius tells us, that the emperor Severus lost no less than 50,000 men in a few years time, in cutting down the woods and draining the bogs of this island. It is not to be wondered at, that such numbers executed the immense destruction which we find in these buried forests. One of the greatest subterranean treasures of wood is that near Hatfield; and it is easy to prove, that these people, to whom this havock is thus attributed, were upon the spot where these trees now lie buried. The common road of the Romans out of the south into the north, was formerly from Lindum (Lincoln) to Segelochum (Little Burrow upon Trent), and from thence to Danum (Doncaster), where they kept a standing garrison of Crispinian horse. A little off on the east, and north-east of their road, between the two last-named towns, lay the borders of the greatest forest, which swarmed with wild Britons, who were continually making their sallies out, and their retreats into it again, intercepting their provisions, taking and destroying their carriages, killing their allies and passengers, and disturbing their garrisons. This at length so exasperated the Romans, that they were determined to destroy it; and to do this safely and effectually, they marched against it with a great army, and encamped on a great moor not far from Fimingly: this is evident from their fortifications yet remaining.

There is a small town in the neighbourhood called *Osterfeld*; and as the termination *feld* seems to have been given only in remembrance of battles fought near the towns whose names ended with it, it is not improbable that a battle was fought here, between all the Britons who inhabited this forest, and the Roman troops under Ostorius. The Romans slew many of the Britons, and drove the rest back into this forest, which at that time overpread all this low country. On this the conquerors taking advantage of a strong south-west wind, set fire to the pitch-trees, of which this forest was principally composed; and when the greater part of the trees were thus destroyed, the Roman soldiers and captive Britons cut down the remainder, except a few large ones which they left

standing as remembrances of the destruction of the rest. These single trees, however, could not stand long against the winds, and these falling into the rivers which ran through the country, interrupted their currents; and the water then overpreading the level country made one great lake, and gave origin to the mosses or moory bogs, which were afterwards formed there, by the workings of the waters, the precipitation of earthy matter from them, and the putrefaction of rotten boughs and branches of trees, and the vast increase of water-moss and other such plants which grow in prodigious abundance in all these sorts of places. Thus were these burnt and felled trees buried under a new-formed spongy and watery earth, and afterwards found on the draining and digging thro' this earth again.

Hence, it is not strange that Roman weapons and Roman coins are found among these buried trees; and hence it is that among the buried trees some are found burnt, some chopped and hewn; and hence it is that the bodies of the trees all lie by their proper roots, and with their tops lying north-east, that is, in that direction in which a south-west wind would have blown them down: hence also it is, that some of the trees are found with their roots lying flat, these being not cut or burned down, but blown up by the roots afterwards when left single; and it is not wonderful, that such trees as these should have continued to grow even after their fall, and shoot up branches from their sides which might easily grow into high trees. Phil. Trans. n<sup>o</sup> 275.

By this system it is also easily explained why the moor soil in the country is in some places two or three yards thicker than in others, or higher than it was formerly, since the growing up of peat-earth or bog-ground is well known, and the soil added by overflowing of waters is not a little.

As the Romans were the destroyers of this great and noble forest, so they were probably also of the several other ancient forests; the ruins of which furnishes us with the bog-wood of Staffordshire, Lancashire, Yorkshire, and other counties. But as the Romans were not much in Wales, in the Isle of Man, or in Ireland, it is not to be supposed that forests cut down by these people gave origin to the fossil wood found there: but though they did not cut down these forests, others did; and the origin of the bog-wood is the same with them and with us. Holinghead informs us, that Edward I. being not able to get at the Welch because of their hiding themselves in boggy woods, gave orders at length that they should all be destroyed by fire and by the ax; and doubtless the roots and bodies of trees found in Pembrokeshire under ground, are the remains of the execution of this order. The fossil wood in the bogs of the island of Man is doubtless of the same origin, though we have not any accounts extant of the time or occasion of the forests there being destroyed; but as to the fossil trees of the bogs of Ireland, we are expressly told, that Henry II. when he conquered that country, ordered all the woods to be cut down that grew in the low parts of it, to secure his conquests, by cutting away the places of resort of rebels.

*Moving-Moss.* We have an account in the Philosophical Transactions, of a moving moss near Church-

Mofs.

town in Lancashire, which greatly alarmed the neighbourhood as miraculous. The mofs was observed to rise to a surprizing height, and soon after sunk as much below the level, and moved slowly towards the south.

A very surprizing instance of a moving mofs is that of Solway in Scotland, which happened in the year 1771, after severe rains which had produced terrible inundations of the rivers in many places. For the better understanding of this event, we shall give the following description of the spot of ground where it happened. Along the side of the river Esk there is a vale, about a mile broad, less or more in different places. It is bounded on the south-east by the river Esk, and on the north-west by a steep bank 30 feet in height above the level of the vale. From the top of the bank the ground rises in an easy ascent for about a quarter of a mile, where it is terminated by the mofs; which extends about two miles north and south, and about a mile and an half east and west, and is bounded on the north-west by the river Sark. It is probable that the solid ground from the top of the bank above the vale was continued in the same direction under the mofs, before its eruption, for a considerable space; for the mofs at the place where the eruption happened, was inclined towards the sloping ground. From the edge of the mofs there was a Gully or hollow, called by the country people *the gap*, and said to be 30 yards deep where it entered the vale; down which ran a small rill of water, which was often dry in summer, having no supply but what filtered from the mofs. The eruption happened at the head of this gap, on Saturday November 16th 1771, about ten or eleven at night, when all the neighbouring rivers and brooks were prodigiously swelled by the rains. A large body of the mofs was forced, partly by the great fall of rain, and partly by some springs below it, into a small beck or burn, which runs within a few yards of its border to the south-east. By the united pressure of the water behind it, and of this beck, which was then very high, it was carried down a narrow glen between two banks about 300 feet high, into a wide and spacious plain, over part of which it spread with great rapidity. The mofs continued for some time to send off considerable quantities; which, being borne along by the torrent on the back of the first great body, kept it for many hours in perpetual motion, and drove it still farther on. This night at least 400 acres of fine arable land were covered with mofs from 3 to 12 or 15 feet deep. Several houses were destroyed, a good deal of corn lost, &c. but all the inhabitants escaped. When the waters subsided, the mofs also ceased to flow; but two pretty considerable streams continued to run from the heart of it, and carried off some pieces of mossy matter to the place where it burst. There they joined the beck already mentioned; which, with this addition, resumed its former channel; and, with a little assistance from the people of the neighbourhood, made its way to the Esk, through the midst of that great body of mofs which obstructed its course. Thus, in a great measure drained, the new mofs fell several feet, when the fair weather came in the end of November, and settled in a firmer and more solid body on the lands it had over-run. By this inundation about 800

acres of arable ground were overflowed before the mofs stopped, and the habitations of 27 families destroyed. Tradition has preserved the memory of a similar inundation in Monteith in Scotland. A mofs there altered its situation in one night, and covered a great extent of ground.

*Moss-Troopers*, a rebellious sort of people in the north of England, that lived by robbery and rapine, not unlike the tories in Ireland, the bucaners in Jamaica, or banditti of Italy. The counties of Northumberland and Cumberland were charged with an yearly sum, and a command of men, to be appointed by justices of the peace, to apprehend and suppress them.

*MOSTRA*, in the Italian music, a mark at the end of a line or space, to shew that the first note of the next line is in that place: and if this note be accompanied with a sharp or flat, it is proper to place these characters along with the *mostra*.

*MOTACILLA*, in ornithology, a genus of birds of the order of passeres; distinguished by a straight beak of a subulated figure, and a lacerated tongue. There are 49 species belonging to this genus; the most remarkable are,

1. The alba, or white wagtail, frequents the sides of ponds and small streams, and feeds on insects and worms. The head, back, and upper and lower side of the neck, as far as the breast, are black; in some the chin is white, and the throat marked with a black crescent: the breast and belly are white; the quill-feathers are dusky; the coverts black, tipped and edged with white. The tail is very long, and always in motion. Mr Willoughby observes, that this species shifts its quarters in the winter; moving from the north to the south of England during that season. In spring and autumn it is a constant attendant on the plough, for the sake of the worms thrown up by that instrument.

2. The flava, or yellow wagtail, migrates in the north of England, but in Hampshire continues the whole year. The male is a bird of great beauty: the breast, belly, thighs, and vent-feathers, being of a most vivid and lovely yellow: the throat is marked with some large black spots; above the eye is a bright yellow line: beneath that, from the bill, crosses the eye, is another of a dusky hue; and beneath the eye is a third of the same colour: the head and upper part of the body is of an olive-green, which brightens in the coverts of the tail; the quill-feathers are dusky; the coverts of the wings olive-coloured; but the lower rows dusky, tipped with yellowish white; the two outermost feathers of the tail half white; the others black, as in the former. The colours of the female are far more obscure than those of the male: it wants also those black spots on the throat. It makes its nest on the ground, in corn-fields: the outside is composed of decayed stems of plants, and small fibrous roots; the inside is lined with hair: it lays five eggs.

3. The regulus, or gold-coloured wren, is a native of Europe, and of the corresponding latitudes of Asia and America. It is the least of all the European birds, weighing only a single drachm. Its length is about four inches and an half; and the wings, when spread out, measure little more than six inches. On the top of its head is a beautiful orange-coloured spot called its *crest*, which it can hide at pleasure; the

Mofs  
||  
Motacilla.Plate  
of A. CLXXXIIII  
fig. 4.

margins

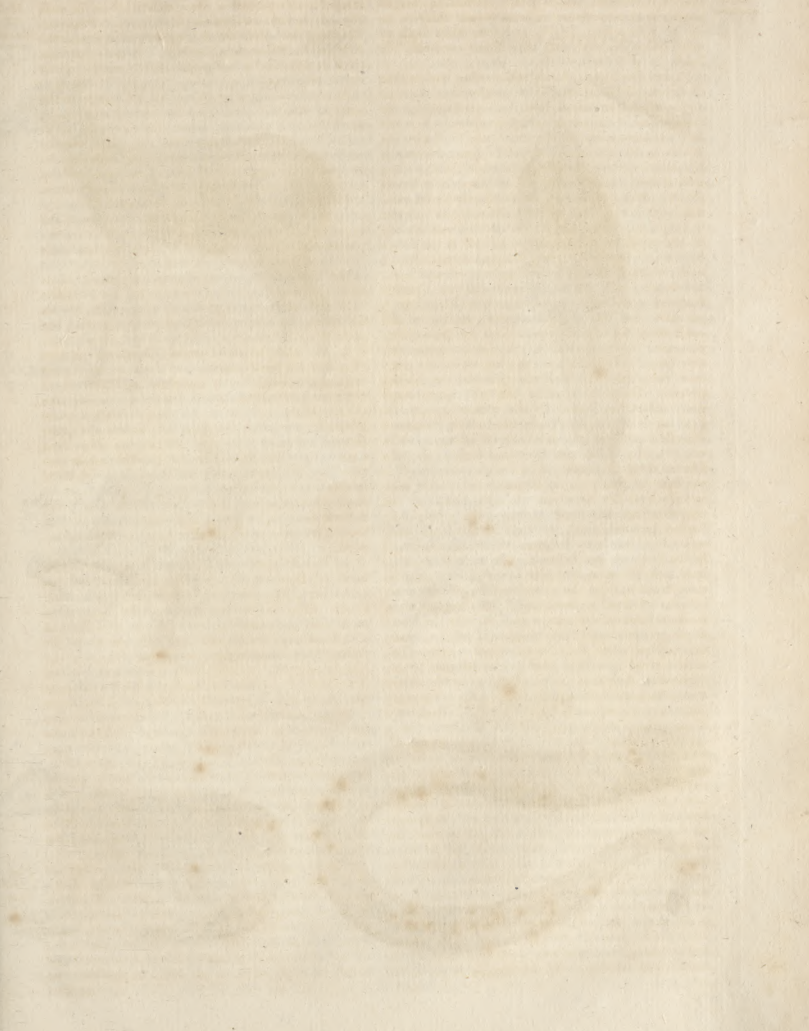


Fig. 1. MOTACILLA Sutoria,  
or Taylor bird.



Plate CLXXXII.

Fig 2  
MOSCHUS Moschiferus,  
or Musk Animal.



Fig. 3.  
MUTILLA Occidentalis,  
or Velvet Ant.



Fig. 4.  
MOTACILLA Regulus.



Fig. 5.  
MURINA Helena,  
The Norway.

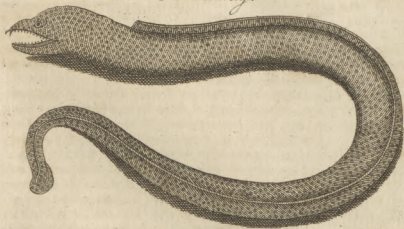


Fig. 6.  
MUS Leporinus,  
or Java Hare.



A. Bell sculpt.

Mote  
Motte.

margins of the crest are yellow, and it ends in a pretty broad black line; the sides of the neck are of a beautiful yellowish green; the eyes surrounded with a white circle; the neck and back of a dark green mixed with yellow; the breast of a dirty white; the tail composed of 12 feathers of a brown colour, an inch and an half long, but not forked. In America it associates with the titmice, running up and down the bark of lofty oaks with them, and collecting its food in their company, as if they were all of one brood. It feeds on insects lodged in their winter dormitories in a torpid state.

4. The falis, or blue-bird, is a native of most parts of North America; and is about the bigness of a sparrow. The eyes are large; the head and upper part of the body, tail, and wings, are of a bright blue, excepting that the ends of the feathers are brown. The throat and breast are of a dirty red. The belly is white. It flies swiftly, having very long wings; so that the hawk generally pursues it in vain. It makes its nest in holes and trees; resembles our robin-red breast in its disposition, and feeds only on insects.

Plate  
CLXXXII.  
fig. 1.

5. The futoria, or taylor-bird, is a native of the East-Indies. It is remarkable for the art with which it makes its nest, seemingly in order to secure itself and its young in the most perfect manner possible against all danger from voracious animals. It picks up a dead leaf, and sews it to the side of a living one: its slender bill is the needle, and its thread is formed of some fine fibres; the lining is composed of feathers, gossamer, and down: its eggs are white, the colour of the bird light-yellow; its length three inches; and its weight only three sixteenths of an ounce, so that the materials of the nest and its own size are not likely to draw down a habitation depending on so slight a tenure.

MOTE, in law-books, signifies court or convention; as a ward-mote, burgh-mote, swain-mote, &c.

MOTE-BELL, or Mot-Bell, the bell so called, which was used by the English Saxons to call people together to the court. See FOLK-MOTE.

MOTH, in zoology. See PHALENA and PAPILIO.

MOTHE LE VAYER (Fransis de la). See VAYER.

MOTHER, a term of relation, denoting a woman who hath born a child.

MOTHER OF Pearl. See PEARL.

MOTTE (Anthony Houdart de la), an ingenious Frenchman, greatly distinguished by his writings in prose and verse, and by his literary contests with many eminent persons, was born at Paris in 1672. He wrote with very different success, no man having been more praised or more criticized than he was: his literary paradoxes, his singular systems, in all branches of polite learning, and above all, his judgment upon the ancients, which, like those of Perrault, were thought disrespectful and detracting, raised him up formidable adversaries. Racine, Boileau, Rousseau, and Madam Dacier, were among the number of those who made it their business to avenue antiquity on a man who, with more wit than genius or learning, assumed a kind of dictatorial authority in the province of belles lettres. He became blind in the latter years of his life, and died in 1731: a complete edition of all his works was published in 11 vols, 8vo. in 1754; though, as has been said of our Swift, his reputation had been better consulted by reducing them to three or four.

MOTION, is defined to be the continued and successive change of place.

There are three general laws of motion.

1. That a body always perseveres in its state of rest, or of uniform motion in a right line, till by some external force it be made to change its state: for as body is passive in receiving its motion, and the direction of its motion; so it retains them, or perseveres in them without any change, till it be acted on by something external. From this law it appears why we inquire not, in philosophy, concerning the cause of the continuation of the motion or rest in bodies, which can be no other than their *inertia*; but if a motion begin, or if a motion already produced is either accelerated or retarded, or if the direction of the motion is altered, an inquiry into the power or cause that produces this change is a proper subject of philosophy.

2. The second general law of motion is, The change of motion is proportional to the force impressed, and is produced in the right line in which that force acts. When a fluid acts upon a body, as water or air upon the vanes of a mill, or wind upon the sails of a ship, the acceleration of the motion is not proportional to the whole force of those fluids, but to that part only which is impressed upon the vanes or sails, which depends upon the excess of the velocity of the fluid above the velocity which the vane or sail has already acquired; for if the velocity of the fluid be only equal to that of the vane or sail, it just keeps up with it, but has no effect either to advance or retard its motion. Regard must always be had to the direction in which the force is impressed, in order to determine the change of motion produced by it: thus, when the wind acts obliquely with respect to the direction of a ship, the change of her motion is first to be estimated in the direction of the force impressed; and thence, by a proper application of mechanical and geometrical principles, the change of the motion of the ship in her own direction is to be deduced. 3. The third general law of motion is, That action and reaction are equal, with opposite directions, and are to be estimated always in the same right line. Body not only never changes its state of itself, but resists by its *inertia* every action that produces a change in its motion: hence when two bodies meet, each endeavours to persevere in its state, and resists any change; the one acquires no new motion, but what the other loses in the same direction; nor does this last lose any force, but what the other acquires: and hence, though, by their collision, motion passes from the one to the other; yet the sum of their motions, estimated in a given direction, is preserved the same, and is unalterable by their mutual actions upon each other.

All motion may be considered absolutely or relatively. Absolute or real motion, says Mr Maclaurin, is when a body changes its place in absolute space; and relative motion, is when a body changes its place only with relation to other bodies.

From the observation of nature, every one knows that there is motion; that a body in motion perseveres in that state, till by the action of some power it is necessitated to change it; that it is not in relative or apparent motion in which it perseveres in consequence of its *inertia*, but in real or absolute motion. Thus the apparent diurnal motion of the sun and stars would

cease, without the least power or force acting upon them, if the motion of the earth was stopt; and if the apparent motion of any star was destroyed by a contrary motion impressed upon it, the other celestial bodies would still appear to persevere in their course.

To make this matter still plainer, Mr Martin observes, that space is nothing but an absolute and infinite void, and that the place of a body is that part of the immense void which it takes up or possesses; and this place may be considered absolutely, or in itself, in which case it is called the *absolute place of the body*; or else with regard to the place of some other body, and then it is called the *relative or apparent place of the body*.

Now, as a motion is only the change of place in bodies, it is evident that it will come under the same distinction of absolute and relative, or apparent. All motion is in itself absolute, or the change of absolute space; but when the motions of bodies are considered and compared with each other, then are they relative and apparent only: they are relative, as they are compared to each other; and they are apparent only, inasmuch that not their true or absolute motion, but the sum or difference of the motions only is perceivable to us.

In comparing the motions of bodies, we may consider them as moving both the same way, or towards contrary parts: in the first case, the difference of motion is only perceived by us; in the latter, the sum of the motions. Thus, for example; suppose two ships, A and B, set sail from the same port upon the same rhumb, and that A sails at the rate of five miles *per* hour, and B at the rate of three; here the difference of the velocity (*viz.* two miles *per* hour) is that by which the ship A will appear to go from the ship B forwards, or the ship B will appear at A to go with the same velocity backwards, to a spectator in either respectively.

If the two ships, A and B, move with the same degree of velocity, then will the difference be nothing, and so neither ship will appear to the other to move at all. Hence it is, that though the earth is continually revolving about its axis; yet as all objects on its surface partake of the same common motion, they appear not to move at all, but are relatively at rest.

If two ships, A and B, with the degrees of velocity as above, meet each other, the one will appear to the other to move with the sum of both velocities, *viz.* at the rate of eight miles *per* hour; so that in this case the apparent motion exceeds the true, as in the other it fell short of it. Hence the reason why a person, riding against the wind, finds the force of it much greater than it really is; whereas if he rides with it, he finds it less.

The reason of all these phenomena of motion will be evident, if we consider that we must be absolutely at rest, if we would discern the true or real motion of bodies about us. Thus a person on the strand will observe the ships sailing with their real velocity. A person standing still will experience the true strength and velocity of the wind; and a person placed in the regions between the planets will view all their true motions, which he cannot otherwise do, because in all other cases the spectator's own motion must be added to or subtracted from that of the moving body.

Motion is either *equable* or *accelerated*.

Equable motion is that by which a body passes

over equal spaces in equal times.

Accelerated motion is that which is continually augmented or increased, as retarded motion is that which continually decreases; and if the increase or decrease of motion be equal in equal times, the motion is then said to be equally accelerated or retarded.

Equable motion is generated by a single impetus or stroke: thus the motion of a ball from a cannon is produced by the single action of the powder in the first moment; and therefore the velocity it first sets out with would always continue the same, were it void of gravity, and to move in an unresisting medium; which therefore would be always equable, or such as would carry it through the same length of space in every equal part of time.

Hence we may determine the theorems for the expressions of the time (T) the velocity (V) and the space (S) passed over in equable or uniform motion very easily thus:

If the time be given, or the same, the space passed over will be as the velocity, *viz.*  $S : V$ ; that is, with twice the velocity, twice the space; with three times the velocity, three times the space, will be passed over in the same time; and so on.

If the velocity be given, or remain the same, then the space passed over will be as the time, *viz.*  $S : T$ ; that is, it will be greater or less, as the time is so.

But if neither the time nor velocity be given or known, then will the space be in the compound ratio of both, *viz.*  $S : TV$ . Hence, in general, since  $S : TV$ ,

we have  $V \propto \frac{S}{T}$ ; that is, the velocity is always directly as the space, and inversely as the time. And also  $T \propto \frac{S}{V}$ ; that is, the time is as the space directly,

and as the velocity inversely; or, in other words, it increases with the space, and decreases with the velocity.

If, therefore, in any rectangle, one side represent the time, and the other side the velocity, it is evident that the area of the said rectangle will represent the space passed over by a uniform motion in that time, and with that velocity.

Accelerated motion is produced by a constant impulse or power, which keeps continually acting upon the body, as that of gravity which produces the motion of falling bodies; which sort of motion is constantly accelerated, because gravity every moment adds a new impulse, which generates a new degree of velocity; and the velocity thus increasing, the motion must be quickened each moment, or the body must fall faster and faster the lower it falls.

In like manner a body thrown perpendicularly upward, as a ball from a cannon, will have its motion continually retarded, because gravity acts constantly upon it in a direction contrary to that given it by the powder; so that its velocity upwards must be continually diminished, and so its motion as continually retarded, till at last it be all destroyed. The body has then attained its utmost height, and is for a moment motionless; after which it begins to descend with a velocity in the same manner accelerated, till it comes to the earth's surface.

Since the momentum (M) of a body is compounded of the quantity of matter (Q), and the velocity (V), we have this general expression  $M = QV$ , for the

force



Motion. force of any body A; and suppose the force of another body B be represented by the same letters in Italics, viz.  $M = QV$ .

Let the two bodies A and B in motion impinge on each other directly; if they tend both the same way, the sum of their motions towards the same part will be  $QV + QV$ . But if they tend towards contrary parts, or meet, then the sum of their motions towards the same part will be  $QV - QV$ ; for since the motion of one of the bodies is contrary to what it was before, it must be connected by a contrary sign. Or thus; because, when the motion of B conspires with that of A, it is added to it; so, when it is contrary, it is subtracted from it, and the sum or difference of the absolute motions is the whole relative motion, or that which is made towards the same part. Again, this total motion towards the same parts, is the same both before and after the stroke, in case the two bodies A and B impinge on each other; because, whatever change of motion is made in one of those bodies by the stroke, the same is produced in the other body towards the same part; that is, as much as the motion of B is increased or decreased towards the same part by the action of A, just so much is the motion of A diminished or augmented towards the same part by the equal re-action of B, by the third law of motion.

In bodies not elastic, let  $x$  be the velocity of the bodies after the stroke (for, since we suppose them not elastic, there can be nothing to separate them after collision; they must therefore both go on together, or with the same celerity). Then the sum of the motions after collision will be  $Qx + Qx$ ; whence, if the bodies tend the same way, we have  $QV + QV = Qx + Qx$ , or if they meet,  $QV - QV = Qx + Qx$ ; and accordingly  $\frac{QV + QV}{Q + Q} = x$ , or  $\frac{QV - QV}{Q + Q} = x$ .

If the body (B) be at rest, then  $V = 0$ , and the velocities of the bodies after the stroke will be  $\frac{QV}{Q + 0} = x$ .

Thus if the bodies be equal (viz.  $Q = Q$ ) and A with 10 degrees of velocity impinge on B at rest; then  $\frac{QV}{Q + Q} = \frac{10}{2} = 5 = x$ . If  $Q = Q$ , and  $V : V' :: 10 : 6$  we have  $\frac{QV + QV'}{Q + Q} = \frac{16}{2} = 8 = x$ , the velocity after the stroke.

If the bodies are both in motion, and tend the contrary way; then when  $Q = Q$  and  $V = V'$ , it is plain  $\frac{QV - QV'}{Q + Q} = 0 = x$ ; that is, the bodies which meet with equal bulks and velocities will destroy each other's motion after the stroke, and remain at rest. If  $Q = Q$  but  $V : V' :: 6 : 14$ , then  $\frac{QV - QV'}{Q + Q} = \frac{-8}{2} = -4 = x$ ; which shews that equal bodies meeting with unequal velocities, they will, after meeting the stroke, both go on the same way which the most prevalent body moved before.

If the velocity  $\frac{QV \pm QV'}{Q + Q}$  be multiplied by the quantities of matter  $Q$  and  $Q$ , we shall have  $\frac{Q^2V \pm Q^2V'}{Q + Q} =$  the momentum of A after the stroke;

and  $\frac{QV \pm QV'}{Q + Q} =$  the momentum B; therefore  $QV - \frac{Q^2V \pm Q^2V'}{Q + Q} = \frac{Q^2V \pm Q^2V'}{Q + Q} = \frac{Q^2}{Q + Q} \times V \mp V' =$  the quantity of the motion lost in A after the stroke, and consequently is equal to what is gained in B, as may be shewn in the same manner.

But since a part of this expression (viz.  $\frac{Q^2}{Q + Q}$ ) is constant, the loss of motion will ever be proportional to the other part  $V \mp V'$ . But this loss or change of motion in either body is the whole effect, and so measures the magnitude or energy of the stroke. Wherefore any two bodies, not elastic, strike each other with a stroke always proportionable to the sum of their velocities ( $V + V'$ ) if they meet, or to the difference of their velocities ( $V - V'$ ) if they tend the same way.

Hence, if one body (B) be at rest before the stroke, then  $V' = 0$ ; and the magnitude of the stroke will be as  $V$ ; that is, as the velocity of the moving body A; and not as the square of its velocity, as many philosophers (viz. the Dutch and Italians) maintain.

In bodies perfectly elastic, the resistent power or spring by which the parts displaced by the stroke restore themselves to their first situation, is equal to the force impressed, because it produces an equal effect; therefore, in this sort of bodies, there is a power of action twice as great as in the former non-elastic bodies; for these bodies not only strike each other by impulse, but likewise by repulse, they always repelling each other after the stroke. But we have shewn, that the force with which non-elastic bodies strike each other is as  $V \pm V'$ ; therefore the reaction of elastic bodies is the same; that is, the velocity with which elastic bodies recede from each other after the stroke, is equal to the velocity with which they approached each other before the stroke. Whence if  $x$  and  $y$  be the velocities of two bodies A and B, tending the same way after the stroke, since  $V - V' = y - x$ , we have  $x + V - V' = y$ ; whence the motion of A after the stroke will be  $Qx$ , and that of B will be  $Qy + QV - QV'$ ; and the sum of these motions will be equal to the sum of the motions before the stroke, viz.  $Qx + Qy + QV - QV' = QV + QV'$ . Whence, by reducing the equation, it will be  $Qx + Qy = QV - QV + 2QV'$ ; and  $x = \frac{QV - QV + 2QV'}{Q + Q} =$  the velocity of the body A.

Again, the velocity of B is  $x + V - V' = \frac{QV - QV + 2QV'}{Q + Q} + V - V' = \frac{2QV - QV' + QV'}{Q + Q}$ . Here

we suppose the bodies tend the same way before the stroke; and it is evident from the equation above, that so long as  $QV + 2QV'$  is greater than  $2QV$ , the velocity ( $x$ ) of A after the stroke will be affirmative, or the body A will move the same way after the stroke as before; but when  $2QV$  is greater than  $QV + 2QV'$ , the velocity ( $x$ ) will be negative, or the body A will be reflected back.

If the body B be at rest, then  $V' = 0$ ; and  $x = \frac{QV - QV}{Q + Q}$ , which shews the body A will go forwards or backwards, as  $QV$  is greater or lesser than  $QV$ , or A greater or lesser than B.

Motion.

If  $Q=3, Q=V=10,$  and  $V=0;$  then after the stroke the velocity of A will be  $x = \frac{QV - QV - 30 - 20 - 10}{Q + Q} = -2,$  and the velocity of B will be  $y = \frac{2QV - 60}{Q + Q} = 12.$  If the bodies are both in motion, and  $V=5,$  the rest is the same as before; then  $\frac{QV - QV + 2QV}{Q + Q} = 6 =$  velocity of A after the stroke, and  $\frac{2QV - QV + QV}{Q + Q} = 11 =$  velocity of B after the stroke.

If the bodies A and B move towards contrary parts, or meet each other, then will the relative velocity, to which the force of the stroke is proportional, be  $V+V;$  and so the velocities of A and B after the stroke will be  $x$  and  $x+V+V;$  and so the motion of A will be  $Qx$  and  $Qx+QV+QV;$  the sum of these motions in  $Qx+Qx+QV+QV=QV-QV=0$  the motion towards the same part before the stroke. Whence we have  $x = \frac{QV - QV - 2QV}{Q + Q},$  and therefore the velocity of B will be  $\frac{QV - QV - 2QV}{Q + Q} + V + V = \frac{2QV + QV - QV}{Q + Q}.$

If  $QV+2QV$  be greater than  $QV,$  the motion of the body A will be backwards; otherwise it will go on forwards as before.

If  $Q=3, Q=2, V=10,$  and  $V=5;$  then will the velocity of A be  $\frac{QV - QV - 2QV}{Q + Q} = -10/5 = -2;$  and so the body A will go back with two degrees of velocity. The velocity of B, after the stroke, will be  $\frac{2QV + QV - QV}{Q + Q} = 13.$

If the bodies are equal, that is, if  $Q=Q,$  then  $x = \frac{-2QV}{2Q} = -V;$  which shews, that when equal bodies meet each other, they are reflected back with interchanged velocities; for in that case also the velocity of B becomes  $\frac{2QV}{2Q} = V.$

If the bodies are equal, and one of them at rest, as B, then since  $Q=Q,$  and  $V=0,$  we have the velocity of A after the stroke  $x=0;$  or the body A will abide at rest, and the velocity of B will be  $=V,$  the velocity of A before the impulse, as appears by the example in the figure referred to.

If several bodies B, C, D, E, F, are contiguous in a right line, and another equal body A strike B with any given velocity, it shall lose all its motion, or be quiescent after the stroke; the body B which receives it will communicate it to C, and C to D, and D to E, and E to F; and because action and reaction between the bodies B, C, D, E, are equal, as they were quiescent before, they must continue so; but the body F, having no other body to re-act upon it, has nothing to obstruct its motion; it will therefore move on with the same velocity which A had at first, because it has all the motion of A, and the same quantity of matter by hypothesis.

Let there be three bodies A, B, C, and let A strike B at rest; the velocity generated in B by the stroke will be  $y = \frac{2QV}{Q + Q},$  and so the momentum of B will be

Motion  
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Motteux.

$\frac{2QVQ}{Q+Q} = Qy.$  With this momentum B will strike C at rest and contiguous to it; the velocity generated in C will be  $\frac{2Qy}{Q+Q};$  and its momentum will be  $\frac{2QyC}{Q+Q} = \frac{2QC}{Q+Q} \times \frac{2QV}{Q+Q} = \frac{4QVQC}{(Q+Q)^2}.$

If now we suppose B a variable quantity, while A and C remain the same, we shall find what proportion it must have to each of them, in order that the momentum of C may be a maximum, or the greatest possible, by putting the fluxion thereof equal to nothing; that is,  $4Q^2C^2VQ - 4QCQ^2Q = 0;$  whence we get  $QC - QC + Q^2 + Q^2C^2 = 0;$  consequently  $Q:Q::Q:C,$  or  $A:B::B:C;$  that is, the body B is a geometrical mean between A and C. Hence if there be any number (n) of bodies in a geometrical ratio (r) to each other, and the first be A, the second will be rA, the third r^2A, and so on to the last, which will be r^{n-1}A.

Also, the velocity of the first being V, that of the second will be  $\frac{2V}{1+r}$  (for  $\frac{2QV}{Q+Q}$  is here  $= \frac{2AV}{A+rA} = \frac{2V}{1+r}$ ) that of the third  $\frac{4V}{1+r^2},$  that of the fourth  $\frac{8V}{1+r^3},$  and so on to the last, which will be  $\frac{2^n}{1+r^{n-1}}V.$

The momentum of the first will be AV, that of the second  $\frac{2rAV}{1+r},$  that of the third  $\frac{4r^2AV}{1+r^2},$  that of the fourth  $\frac{8r^3AV}{1+r^3},$  and so on to the last, which will be  $\frac{2r^{n-1}AV}{1+r^{n-1}}.$

To give an example of this theorem; if  $n=100,$  and  $r=2,$  then will the first body A be to the last  $r^{n-1}A,$  as 1 to 633825300000000000000000000000000, nearly; and its velocity to that of the last nearly as 271022000000000000 to 1; lastly, the momentum of the first to that of the last will be nearly as 1 to 23384800000000.

If the number (n) of bodies be required, and the ratio of the momenta of the first and last be given as 1 to M, and the ratio of the series r given also; then, putting  $\frac{2r}{1+r} = R,$  we have the momentum of the last body expressed by  $\frac{2r^n}{1+r^{n-1}} = M = R^{n-1};$  therefore the logarithm of M (l.M) is equal to the logarithm of R (l.R) multiplied by the power n-1; that is,  $l.M = n-1 \times l.R;$  consequently  $\frac{l.M}{l.R} + 1 = n,$  the number of bodies required.

MOTTEUX (Peter), a French gentleman, born and educated at Rouen in Normandy. Coming over to England on account of the persecution of the Protestants, he became a considerable trader in London, kept an East-India warehouse in Leadenhall-street, and had a genteel place in the general post-office, relating to foreign letters, being master of several languages.

**Motto** **guages.** He was a man of wit and humour; and acquired to perfect a mastery of the English language, that he not only was qualified to oblige the world with a very good translation of Don Quixote, but also wrote several songs, prologues, epilogues, &c. and what was still more extraordinary, became a very eminent dramatic writer in a language to which he was not a native. He was at last, in the year 1718, found dead in a disorderly house, on his birth-day, when he completed his 58th year.

**MOTTO**, in armoury, a short sentence or phrase, carried in a scroll, generally under, but sometimes over, the arms; sometimes alluding to the bearings, sometimes to the name of the bearer, and sometimes containing whatever pleases the fancy of the deviser.

**MOVEABLE**, in general, denotes any thing capable of being moved.

**MOVEABLE Subjects**, in Scots law, any thing that moves itself, or can be moved; in contradistinction to immoveable or heritable subjects, as lands, houses, &c.

**MOVEMENT**, in mechanics, a machine that is moved by clock-work. See **CLOCK** and **WATCH**.

**Perpetual MOVEMENT.** Many have attempted to find a perpetual movement, but without success; and there is reason to think, from the principles of mechanics, that such a movement is impossible: for tho', in many cases of bodies acting upon one another, there is a gain of absolute motion, yet the gain is always equal in opposite directions; so that the quantity of direct motion is never increased.

To make a perpetual movement, it appears necessary that a certain system of bodies, of a determined number and quantity, should move in a certain space for ever, and in a certain way and manner; and for this there must be a series of actions returning in a circle, otherwise the movement will not be perpetual; so that any action by which the absolute quantity of force is increased, of which there are several sorts, must have its corresponding counter-action, by which the gain is destroyed, and the quantity of force restored to its first state.

Thus by these actions there will never be any gain of direct force to overcome the friction and resistance of the medium; so that every motion being diminished by these resistances, they must at length languish and cease.

**MOVING PLANTS.** See **HEDYSARUM**, **TREMELLA**, and **MIMOSA**.

**MOULD**, or **MOLD**, in the mechanic arts, a cavity cut with a design to give its form or impression to some softer matter applied therein; of great use in **SCULPTURE**, **FOUNDERY**, &c. See their articles.

**MOULD**, in agriculture, a loose kind of earth, everywhere obvious on the surface of the ground, called also *natural* or *mother earth*; by some also *loam*. For an account of the nature and properties of this earth, see **AGRICULTURE**, Part I.

**MOULDINESS**, a term applied to bodies which corrupt in the air, from some hidden principle of humidity therein; and whose corruption shews itself by a certain white down or languor on their surface, which, viewed through a microscope, appears like a kind of meadow, out of which arise herbs and flowers, some only in the bud, others full-blown, and others de-

cayed; each having its root, stalk, and other parts. See **MUCOR**.

**MOULDING**, any thing cast in a mould, or that seems to have been so though in reality it were cut with a chisel or the ax.

**MOULDINGS**, in architecture, projections beyond the naked wall, column, waincoat, &c. the assemblage of which forms corniches, door-cases, and other decorations of **ARCHITECTURE**. See that article.

**MOULIN** (Charles du), a celebrated civilian, and one of the most learned men of the 16th century, was born of a considerable family at Paris in 1500, and acquired great reputation by his skill in the law. He published many works, which have been collected together, and printed in five volumes folio; and are justly considered as the most excellent works that France has produced on the subject of civil law. He died at Paris in 1566.

**MOULIN** (Peter du), a Protestant divine, believed to be of the same family with the former, was born in 1568. He taught philosophy at Leyden; and afterwards became chaplain to the prince of Navarre. At the king of England's desire he came hither in 1615, and prepared a plan for the union of the Protestant churches. The university of Leyden offered him a professorship of divinity in 1619; but he refused it, and presided at the synod held by the Calvinists at Als in 1620. Some time after, being informed by Mr Dreincourt that the French king resolved to have him thrown into prison, he retired to Sedan, where the duke de Bouillon made him professor of divinity, and minister in ordinary. He was employed by the Calvinists in the most important affairs; and died at Sedan in 1658. His principal works are, 1. The anatomy of Arminianism. 2. A treatise on repentance, and the keys of the church. 3. The Capuchine, or the history of those monks. 4. The buckler of faith, or a defence of the reformed churches. 5. The judge of controversies and traditions. 6. The anatomy of the mass. 7. The novelty of Popery.

*Peter du Moulin*, his eldest son, was chaplain to Charles II. of England, and prebendary of Canterbury, where he died in 1684, aged 84. He wrote, 1. The peace of the soul, in French. 2. *Glamor regii sanguinis*; which Milton, by mistake, attributed to Alexander Morus. 3. A defence of the Protestant religion, in English.

**MOULINET**, is used, in mechanics, to signify a roller, which, being crossed with two levers, is usually applied to cranes, capitans, and other sorts of engines of the like nature, to draw ropes, and heave up stones, &c.

**MOULINET** is also a kind of turnstile, or wooden cross, which turns horizontally upon a stake fixed in the ground; usually placed in passages to keep out horses, and to oblige passengers to go and come one by one. These moulinets are often let near the out-works of fortified places at the sides of the barriers, through which people pass on foot.

**MOUND**, a term used for a bank or rampart, or other fence, particularly that of earth.

**MOUND**, in heraldry, a ball or globe with a cross upon it, such as our kings are usually drawn with, holding it in their left hand, as they do the sceptre in the right.

**MOUNT**,

**Motto**  
**foulinefs.**

**Moulding**  
**Mountain.**

Mount.

**MOUNT**, an elevation of earth, called also *mountain*. See **MOUNTAIN**.

**MOUNT of Piety**, certain funds or establishments in Italy, where money is lent out on some small security. There were also mounts of piety in England, raised by contribution for the benefit of people ruined by the extortions of the Jews.

**MOUNTAIN**, a part of the earth rising to a considerable height above the level of the surface thereof.

The origin of mountains is variously assigned by philosophers: some will have them coeval with the world, and created along with it; others, among whom is Dr Burnet, will have them to take their rise from the deluge, urging that the extreme irregularity and disorder visible in them, plainly shews they do not come immediately out of the hand of God, but are the wrecks of the old world, broken into the abyss. See **DELUGE**.

Others again allege from history, that the roots of many hills being eaten away, the hills themselves have subsided and sunk into plains; whence they conclude, that where the corruption is natural, the generation is so too. It appears certain to many, that some mountains must have generated gradually, and have grown up in process of time, from the sea-shells, &c. found in them, which they suppose may be accounted for from a violent wind blowing the sand, &c. into huge heaps, which were made into a mass by the rain, &c. The origin of mountains, in the opinion of Mr Ray, seems to have been from explosions by means of subterraneous fires; and he thinks it very probable, that they all have vast hollows beneath them: and that this might have been the means used at the creation to make the dry land appear, he thinks no way difflant to reason, since history proves that fires have raged in subterraneous caverns under the seas; and there is no natural impossibility in fire's subsiding in such caverns, even when the earth was all over covered with water, as at the first creation.

Mountains appear to many to be defects and blemishes in the earth; but they are truly of the utmost use and necessity to the well-being both of man and other animals. They serve as screens to keep off the cold and nipping blasts of the northern and eastern winds; they serve for the production of a great number of vegetables and minerals, which are not found in any other soil; the long ridges and chains of lofty and topping mountains, being generally found to run from east to west, serve to stop the evagation of the vapours towards the poles, without which they would all run from the hot countries, and leave them destitute of rain. Mr Ray adds, that they condense these vapours, like alembic heads, into clouds; and so, by a kind of external distillation, give origin to springs and rivers; and by amassing, cooling, and confining them, turn them into rain, and by that means render the fervid region of the torrid zone habitable. He farther adds, that many creatures cannot live but in particular situations; and even the tops of the highest and the coldest mountains are the only places where some creatures, as well birds as quadrupeds, will live.

M. Buffon remarks, that the highest mountains of the world, as well as the largest, are situated in the

Mount.

torrid zone; and the nearer we approach the equator, the greater are the inequalities on the earth's surface. "A short enumeration of mountains and islands (says he) will be sufficient to establish this point.—In America, the Cordilleras, which are the highest mountains in the world, lie precisely under the equator; and they extend on both sides a considerable way beyond the tropic circles. The highest mountains of the Moon, of Monomotapa, and the great and little Atlas in Africa, lie either under or very near the equator. In Asia, mount Caucasus, the chain of which, under different names, runs into China, and through this whole extent, lies nearer the equator than the poles. In Europe, the Pyrenees, the Alps, and the mountains of Greece, which form one chain, are still less distant from the equator than the pole.

"These chains of mountains of which we have given an enumeration, are higher and of greater extent, both in length and breadth, than those of more northern countries. With regard to their direction, the Alps form a continued chain which runs across the whole continent from Spain to China. They commence on the sea-coast of Galicia, join the Pyrenees, traverse France by Vivares and Auvergne, run through Italy, and stretch into Germany above Dalmatia, until they reach Macedonia; from thence they join the mountains of Armenia, the Caucasus, the Taurus, the Imaus, and at last terminate on the coast of Tartary. Mount Atlas in the same manner traverses the whole continent of Africa, from the kingdom of Fez to the Straits of the Red Sea. The mountains of the moon have likewise the same direction; but the mountains of America have an opposite direction. The vast chains of Cordilleras, and other mountains, run more from south to north than from east to west."

This assertion concerning the magnitude and height of mountains, is no doubt necessary for the support of his theory of the earth\*; but it is by no means agreeable to fact. The mountains of the moon, though much nearer the equator than the Alps, are not, by all accounts, equal to them in size; one of the peaks of the Alps, named *Mont Blanc*, being reckoned the highest point of land in Europe, Asia, or Africa. According to some late computations, this peak is more than 800 feet higher than mount *Ætna* would be with Vesuvius set on its top; so that we may reckon it little inferior to the highest mountains even in America. In Mr Forster's account of the Southern Thule also, he tells us of an exceeding high mountain seen on that island, and which was thought to be little less than two miles perpendicular; and yet this island lies in a very considerable south latitude: so that the height of mountains seems by no means to be in proportion to the vicinity of the equator or torrid zone.

The most remarkable mountain in the world for shape, is that called the *needle mountain*, or the *inaccessible mountain*, in Dauphiny.—This is a vast hill, placed as it were bottom upwards, or set on its summit on the earth, with its broad base elevated in the air; it is but about 1000 paces in circumference at bottom, and above 2000 at the top. On the centre of the plain at the top there stands another small and very narrow, but very high hill. It obtained its name from

\* See Earth.

Mountain. from the supposed impossibility of ascending it, on account of its projection outwards. Some hardy persons, however, once ventured to climb it; and found at the top a number of the chamois, animals by no means qualified for climbing, and which doubtless had never either ascended or descended the mountain, and which must be supposed to have bred there for many ages; though it is very difficult to account for their coming there.

The difficulty and danger of ascending to the tops of mountains, proceeds not from the thinness of the air as has been commonly reported; but the reason is, that they rise with such a rugged and precipitate ascent, that they are utterly inaccessible. In some places they appear like a great wall of 600 or 700 feet high; in others, there stick out enormous rocks, that hang upon the brow of the steep, and every moment threaten destruction to the traveller below.

In this manner almost all the tops of the highest mountains are bare and pointed. And this naturally proceeds from their being so continually assailed by thunders and tempests. All the earthy substances with which they might have been once covered, have for ages been washed away from their summits; and nothing is left remaining but immense rocks, which no tempest has hitherto been able to destroy.

Nevertheless, time is every day and every hour making depredations; and huge fragments are seen tumbling down the precipice, either loosened from the summit by the frost or rains, or struck down by lightning. Nothing can exhibit a more terrible picture than one of these enormous rocks, commonly larger than an house, falling from its height with a noise louder than thunder, and rolling down the side of the mountain. Dr Plot tells us of one in particular, which being loosened from its bed, tumbled down the precipice, and was partly shattered into a thousand pieces. Notwithstanding, one of the largest fragments of the same, still preserving its motion, travelled over the plain below, crossed a rivulet in the midst, and at last stopped on the other side of the bank! These fragments, as was said, are often struck off by lightning, and sometimes undermined by rains; but the most usual manner in which they are disunited from the mountain, is by frost: the rains insinuating between the interstices of the mountain, continue there until there comes a frost; and then, when converted into ice, the water swells with an irresistible force, and produces the same effect as gun-powder, splitting the most solid rocks, and thus shattering the summits of the mountain.

But not rocks alone, but whole mountains, are, by various causes, disunited from each other. We see, in many parts of the Alps, amazing clefts, the sides of which so exactly correspond with the opposite, that no doubt can be entertained of their having been once joined together. At Cajeta, in Italy, a mountain was split in this manner by an earthquake; and there is a passage opened through it, that appears as if elaborately done by the industry of man. In the Andes these breaches are frequently seen. That at Thermopylæ, in Greece, has been long famous. The mountain of the Troglodytes, in Arabia, has thus a passage through it: and that in Savoy, which nature began, and which Victor Amadeus completed, is an instance

of the same kind.

We have accounts of some of these disruptions, immediately after their happening. "In the month of June, in the year 1714, a part of the mountain of Diableret, in the district of Valais, in France, suddenly fell down, between two and three o'clock in the afternoon, the weather being very calm and serene. It was of a conical figure, and destroyed 55 cottages in the fall. Fifteen persons, together with about 100 beasts, were also crushed beneath its ruins, which covered an extent of a good league square. The dust it occasioned instantly covered all the neighbourhood in darkness. The heaps of rubbish were more than 300 feet high. They stopped the current of a river that ran along the plain, which now is formed into several new and deep lakes. There appeared, through the whole of this rubbish, none of those substances that seemed to indicate that this disruption had been made by means of subterraneous fires. Most probably, the base of this rocky mountain was rotted and decayed; and thus fell, without any extraneous violence." In the same manner, in the year 1618, the town of Pleurs, in France, was buried beneath a rocky mountain, at the foot of which it was situated.

These accidents, and many more that might be enumerated of the same kind, have been produced by various causes: by earthquakes, as in the mountain at Cajeta; or by being decayed at the bottom, as at Diableret. But the most general way is, by the foundation of one part of the mountain being hollowed by waters, and thus wanting a support, breaking from the other. Thus it generally has been found in the great chafms in the Alps; and thus it almost always is known in those disruptions of hills which are known by the name of *land-slips*. There are nothing more than the sliding down of an higher piece of ground, disrooted from its situation by subterraneous inundations, and settling itself upon the plain below.

There is not an appearance in all nature that so much astonished our ancestors as these land-slips. In fact, to behold a large upland, with its houses, its corn, and cattle, at once loosened from its place, and floating as it were upon the subjacent water; to behold it quitting its ancient situation, and travelling forward like a ship, in quest of new adventures; this is certainly one of the most extraordinary appearances that can be imagined; and, to a people ignorant of the powers of nature, might well be considered as a prodigy. Accordingly, we find all our old historians mentioning it as an omen of approaching calamities. In this more enlightened age, however, its cause is very well known; and, instead of exciting ominous apprehensions in the populace, it only gives rise to some very ridiculous law-suits among them, about whose the property shall be; whether the land which has thus slipped, shall belong to the original possessor, or to him upon whose grounds it has encroached and settled. What has been the determination of the judges is not so well known; but the circumstances of the slips themselves have been minutely enough and exactly described.

In the lands of Slatberg, in the kingdom of Ireland, there stood a declivity gradually ascending for near half a mile. In the year 1713, and on the 10th of March,

Mountain.

Mountain. the inhabitants perceived a crack on its side, somewhat like a furrow made with a plough, which they imputed to the effects of lightning, as there had been thunder the night before. However, on the evening of the same day, they were surpris'd to hear an hideous confused noise issuing all round from the side of the hill; and their curiosity being rais'd, they resort'd to the place. There, to their amazement, they found the earth for near five acres all in gentle motion, and sliding down the hill upon the subjacent plain. This motion continued the remaining part of the day, and the whole night: nor did the noise cease during the whole time; proceeding, probably, from the attrition of the ground beneath. The day following, however, this strange journey down the hill ceased entirely; and above an acre of the meadow below was found covered with what before compos'd a part of the declivity.

However, these slips, when a whole mountain's side seems to descend, happen but very rarely. There are some of another kind, however, much more common; and, as they are always sudden, much more dangerous. These are snow-slips, well known, and greatly dreaded by travellers. It often happens, that when snow has long been accumulated on the tops and on the sides of mountains, it is borne down the precipice either by means of tempests or its own melting. At first, when loosened, the volume in motion is but small; but it gathers as it continues to roll, and, by the time it has reached the habitable parts of the mountain, it is generally grown of enormous bulk. Wherever it rolls, it levels all things in its way; or buries them in unavoidable destruction. Instead of rolling, it sometimes is found to slide along from the top; yet even thus it is generally as fatal as before. Nevertheless, we have had an instance, a few years ago, of a small family in Germany that lived for above a fortnight beneath one of these snow-slips. Although they were buried during that whole time in utter darkness, and under a bed of some hundred feet deep, yet they were luckily taken out alive, the weight of the snow being supported by a beam that kept up the roof; and nourishment being supplied them by the milk of a she-goat that was buried under the same ruin.

*Attraction of MOUNTAINS.* This is a late discovery, and a very considerable confirmation of Sir Isaac Newton's theory of universal gravity. According to the Newtonian system, an attractive power is not only exerted between those large masses of matter which constitute the sun and planets; but likewise between all comparatively smaller bodies, and even between the smallest particles of which they are compos'd. Agreeably to this hypothesis, a heavy body, which ought to gravitate or tend toward the centre of the earth, in a direction perpendicular to its surface, supposing the said surface to be perfectly even and spherical, ought likewise, though in a less degree, to be attracted and tend towards a mountain placed on the earth's surface: so that a plumb-line, for instance, of a quadrant, hanging in the neighbourhood of such a mountain, ought to be drawn from a perpendicular situation, in consequence of the attractive power of the quantity of matter of which it is compos'd, acting in a direction different from that exerted by the whole

mass of matter in the earth, and with a proportionally inferior degree of force.

Though Sir Isaac Newton had long ago hinted at an experiment of this kind; and had remarked, that "a mountain of a hemispherical figure, three miles high and six broad, would not, by its attraction, draw the plumb-line two minutes out of the perpendicular (A):" yet no attempt to ascertain this matter, by actual experiment, was made till about the year 1738; when the French academicians, particularly Messrs Bouguer and Condamine, who were sent to Peru to measure a degree under the equator, attempted to discover the attractive power of Chimborazo, a mountain in the province of Quito. According to their observations, which were however made under circumstances by no means favourable to an accurate solution of so nice and difficult a problem, the mountain Chimborazo exerted an attraction equal to eight seconds. Though this experiment was not perhaps sufficient to prove satisfactorily even the reality of an attraction, much less the precise quantity of it; yet it does not appear that any steps had been since taken to repeat it.

Through the munificence of his Britannic majesty, the royal society were enabled to undertake the execution of this delicate and important experiment; the astronomer royal was chosen to conduct it. After various inquiries, the mountain Schehallien, situated nearly in the centre of Scotland, was pitched upon as the most proper for the purpose that could be found in this island. The observations were made by taking the meridian zenith distances of different fixed stars, near the zenith, by means of a zenith sector of ten feet radius; first on the south, and afterwards on the north side of the hill, the greatest length of which extended in an east and west direction.

It is evident, that if the mass of matter in the hill exerted any sensible attraction, it would cause the plumb-line of the sector, through which an observer viewed a star in the meridian, to deviate from its perpendicular situation, and would attract it contrary ways at the two stations, thereby doubling the effect. On the south side the plummet would be drawn to the northward, by the attractive power of the hill placed to the northward of it: and on the north side, a contrary and equal deflection of the plumb-line would take place, in consequence of the attraction of the hill, now to the southward of it. The apparent zenith distances of the stars would be affected contrarywise; those being increased at the one station which were diminished at the other: and the correspondent quantities of the deflection of the plumb-line would give the observer the sum of the contrary attractions of the hill, acting on the plummet at the two stations; the half of which will of course indicate the attractive power of the hill.

The various operations requisite for this experiment lasted about four months; and from them it appears, that the sum of the two contrary attractions of the mountain Schehallien, in the two temporary observations which were successively fixed half-way up the hill (where the effect of its attraction would be greatest) was equal to 11". 6.—From a rough computation, founded on the known law of gravitation, and

A By a very easy calculation it is found that such a mountain would attract the plumb-line 1' 18" from the perpendicular.

**Mountain.** and on an assumption that the density of the hill is equal to the mean density of the earth; it appears that the attraction of the hill should amount to about the double of this quantity. From thence it was inferred, that the density of the hill is only about half the mean density of the earth. It does not appear, however, that the mountain Schellien has ever been a volcano, or is hollow; as it is extremely solid and dense, and seemingly composed of an entire rock.

The inference drawn from these experiments may be reduced to the following:

"1. It appears, that the mountain Schellien exerts a sensible attraction; therefore, from the rules of philosophising, we are to conclude, that every mountain, and indeed every particle of the earth, is endued with the same property, in proportion to its quantity of matter.

"2. The law of the variation of this force, in the inverse ratio of the squares of the distances, as laid down by Sir Isaac Newton, is also confirmed by this experiment. For if the force of attraction of the hill had been only to that of the earth as the matter in the hill to that of the earth, and had not been greatly increased by the near approach to its centre, the attraction thereof must have been wholly insensible. But now, by only supposing the mean density of the earth to be double to that of the hill, which seems very probable from other considerations, the attraction of the hill will be reconciled to the general law of the variation of attraction in the inverse duplicate ratio of the distances, as deduced by Sir Isaac Newton from the comparison of the motion of the heavenly bodies with the force of gravity at the surface of the earth; and the analogy of nature will be preserved.

"3. We may now, therefore, be allowed to admit this law, and to acknowledge, that the mean density of the earth is at least double of that at the surface; and consequently that the density of the internal parts of the earth is much greater than near the surface. Hence also, the whole quantity of matter in the earth will be at least as great again as if it had been all composed of matter of the same density with that at the surface; or will be about four or five times as great as if it were all composed of water.—This conclusion, Mr Maskelyne adds, is totally contrary to the hypothesis of some naturalists, who 'suppose the earth to be only a great hollow shell of matter; supporting itself from the property of an arch, with an immense vacancy in the midst of it.' But, were that the case, the attraction of mountains, and even smaller inequalities in the earth's surface, would be very great, contrary to experiment, and would affect the measures of the degrees of the meridian much more than we find they do; and the variation of gravity, in different latitudes, in going from the equator to the poles, as found by pendulums, would not be near so regular as it has been found by experiment to be.

"4. As mountains are, by these experiments, found capable of producing sensible deflections of the plumb-lines of astronomical instruments; it becomes a matter of great importance, in the mensuration of degrees in the meridian, either to choose places where the irregular attractions of the elevated parts may be small; or where, by their situation, they may compensate or counteract the effects of each other."

For measuring the heights of mountains, see the article **BAROMETER**, and the same in the **APPENDIX**.

**MOUSE**, in zoology. See **MUS**.

**MOUSE-EAR**, in botany. See **HIERACHIUM**.

**MOUSE-TAIL**. See **MYOSURUS**.

**DOR-MOUSE**. See **SOREX**.

**MOUSUL**, or **MOSUL**, a town of Turkey in Asia, seated on the western bank of the river Tigris, nearly opposite to the place where Nineveh formerly stood. It is a large place, surrounded with high walls; but the houses are ill-built, and in several places gone to ruin; however, it has a strong castle and a citadel. It is a place of great trade, particularly in cloth and all sorts of cottons and silks. At some distance from Mosul is a mosque, in which they pretend the prophet Jonah lies. The inhabitants are generally Mahometans; but there are a great number of Nestorian Christians. It was besieged in vain by the Persians in 1743. E. Lon. 41. 45. N. Lat. 35. 30.

**MOUTH**, in anatomy, a part of the face, consisting of the lips, the gums, the insides of the cheeks, the palate, the salival glands, the os hyoides, the uvula, and the tonsils; which see under the article **ANATOMY**.

Mr Derham observes, that the mouth in the several species of animals is nicely adapted to the uses of such a part, and well sized and shaped for the formation of speech, the gathering and receiving of food, the catching of prey, &c. In some creatures it is wide and large, in others little and narrow; in some it is formed with a deep incisure into the head, for the better catching and holding of prey, and more easy comminution of hard, large, and troublesome food; and in others with a shorter incisure, for the gathering and holding of herbaceous food. In birds, it is neatly shaped for piercing the air; hard and horny, to supply the want of teeth; hooked, in the rapacious kind, to catch and hold their prey; long and slender in those that have their food to grope for in moorish places; and broad and long in those that search for it in the mud. Nor is the mouth less remarkable in insects: in some it is forcipated, to catch, hold, and tear the prey; in others sculcated, to pierce and wound animals, and suck their blood; in others, strongly rigid, with jaws and teeth, to gnaw and scrape out their food, carry burdens, perforate the earth, nay the hardest wood, and even stones themselves, for houses and nests for their young.

**MOXA**, also called *artemisia Chinensis*. *Moxa*, or *mugwort* of China. It is a soft lauginous substance, prepared in Japan from the young leaves of a species of mugwort, by beating them together when thoroughly dried, and rubbing them betwixt the hands, till only the fine fibres are left.

The down on the leaves of mullein, cotton, hemp, &c. do as well as moxa.

In the Eastern countries it is used by burning it on the skin: a little cone of the moxa is laid upon the part, previously moistened, and set on fire at the top; it burns down with a temperate glowing heat, and produces a dark-coloured spot, the exulceration of which is promoted by applying a little garlic; the ulcer is left to discharge, or is soon healed, according to the intention in using the moxa. See **ARTEMISIA**.

Mofe

Moxa.

MOYLE (Walter), a learned English writer in the 18th century, descended of a good family in Cornwall, where he was born in 1672. He was sent to Oxford, and thence removed to the temple; where he applied himself chiefly to the general, and more noble parts of the law, such as led him to the knowledge of the constitution of the English government. In 1697 he had a share with Mr Trenchard in writing a pamphlet, intitled, "An argument shewing that a standing army is inconsistent with a free government, and absolutely destructive to the constitution of the English monarchy." He translated Xenophon's discourse upon improving the state of Athens. He was for some time member of parliament, in which he always acted an honourable part; applying himself to the improvement and regulation of trade, and the employment of the poor, which has so near a connection with trade. He afterwards retired to his seat at Bake in Cornwall, where he applied himself with vigour to his studies, and died in 1721. In 1726, his works were printed at London, in 2 vols 8vo.

MUCILAGE, in pharmacy, is in general any viscid or glutinous liquor.

MUCILAGE, also imports the liquor which principally serves to moisten the ligaments and cartilages of the articulations; and is supplied by the mucilaginous glands.

MUCOR, in botany, a genus of the order of fungi, belonging to the cryptogamia class of plants. There are 12 species; the most remarkable of which are, 1. The *spirocephalus*, or grey round-headed mucor, growing upon rotten wood, and sometimes upon decayed plants and mosses. The stalks of this are generally black; about a line in height, bearing each at the top a spherical ball about the size of a pin's head; its coat or rind is covered with a grey powder, and containing within a black or fuscous spongy down. The coat bursts with a ragged, irregular margin. 2. The *lichenoides*, or little, black, pin headed mucor. This species grows in groups near to each other, in chasms of the barks of old trees, and upon old park-pales. The stalks are black, about two lines in height; bearing each a single head, sometimes a double or treble one, of the size of mustard or poppy seeds, of a roundish figure at first, but when burst often flattish or truncated, and of a black colour. The internal powdered down is black, with a tinge of green. 3. The *mucedo*, or common grey mould, grows on bread, fruits, plants, and other substances in a putrid state. It grows in clusters; the stalks a quarter of an inch high, pellucid, hollow, and cylindrical; supporting each a single globular head, at first transparent, afterwards dark grey; which bursts with elastic force, and ejects small round seeds discoverable by the microscope. 4. The *glaucus*, or grey cluster-headed mould, is found on rotten apples, melons, and other fruits; as also upon decayed wood, and the stalks of wheat. There are of a pellucid grey colour; the stalks generally single, supporting a spherical ball, which, when magnified, appears to be compounded of numerous, fine, moniliform, necklace-like radii. 5. The *crustaceus*, or fingered mould, is frequent upon corrupted food of various kinds. It is of a white aqueous colour; the stalks single, each supporting at the top four or five necklace-like radii, diverging from the same

point or centre. 6. The *septicus*, or yellow frothy mucor, is found on the leaves of plants, such as ivy and beech, &c. sometimes upon dry sticks, and frequently upon the tan or bark in hot-houses. It is of no certain size or figure, but of a fine yellow colour, and a substance resembling at first cream beat up into froth. In the space of 24 hours it acquires a thin filmy coat, becomes dry, and full of a foamy powder adhering to downy threads. The feeds under the microscope appear to be globular. Haller ranks it under a new genus, which he terms *fuligo*; the characters of which are, that the plants contained under it are soft, and like butter at first, but soon change into a black foamy powder.

MUCUS, a mucilaginous liquor secreted by certain glands, and serving to lubricate many of the internal cavities of the body. In its natural state it is generally limpid and colourless; but, from certain causes, will often assume a thick consistence and whitish colour like pus. As it is sometimes of very great importance in medicine to distinguish these two fluids from each other, this was lately proposed as the subject of a prize-disputation by the *Æsculapian Society* of Edinburgh. The prize was gained by Mr Charles Darwin student of medicine from Litchfield. The conclusions drawn from his experiments were,

1. Pus and mucus are both soluble in the vitriolic acid, though in very different proportions, pus being by far least soluble.

2. The addition of water to either of these compounds decomposes it. The mucus thus separated, either swims in the mixture, or forms large flocculi in it; whereas the pus falls to the bottom, and forms, on agitation, an uniform turbid mixture.

3. Pus is diffusable through a diluted vitriolic acid, though mucus is not. The same also occurs with water, or with a solution of sea salt.

4. Nitrous acid dissolves both pus and mucus. Water added to the solution of pus produces a precipitate, and the fluid above becomes clear and green, while water and the solution of mucus form a turbid dirty-coloured fluid.

5. Alkaline lixivium dissolves, though sometimes with difficulty, mucus, and generally pus.

6. Water precipitates pus from such a mixture, but does not mucus.

7. Where alkaline lixivium does not dissolve pus, it still distinguishes it from mucus, as it then prevents its diffusion through water.

8. Coagulable lymph is neither soluble in concentrated nor diluted vitriolic acid.

9. Water produces no change on a solution of serum in alkaline lixivium, until after long standing, and then only a very slight sediment appears.

10. Corrosive sublimate coagulates mucus, but does not pus.

From the above experiments it appears, that strong vitriolic acid and water, diluted vitriolic acid, and caustic alkaline lixivium and water, will serve to distinguish pus from mucus; that the vitriolic acid separate it from coagulable lymph, and alkaline lixivium from serum.

Hence, when a person has any expectorated matter, the composition of which he wishes to ascertain, let him dissolve it in vitriolic acid, and in caustic alkaline



line lixivium. And let him add pure water to both solutions. If there be a fair precipitation in each, he may be assured that some pus is present. But if there be a precipitation in neither, it is a certain test that the mixture is entirely mucus. If the matter cannot be made to dissolve in alkaline lixivium by time and trituration, we have also reason to believe that it is pus.

MUD-INOANA, the American name of a remarkable kind of two-footed amphibious animal found in South Carolina, first observed by Dr Garden of Charlestown, and afterwards described by John Ellis, F.R.S. in the Phil. Transf. p. 189.

"It is found (says he) in swampy and muddy places, by the side of pools, under the trunks of old trees that hang over the water.

"The lesser one B, which is preserved in spirits, measures about 9 inches in length; and appears to be a very young state of the animal, as we may observe from the fin of the tail, and the opercula or coverings of the gills being not yet extended to their full size. These opercula, in their present state, consist each of three indented lobes, hiding the gills from view, and are placed just above the two feet. These feet appear like little arms and hands, each furnished with four fingers, and each finger with a claw.

"In the specimen A, which is 31 inches long, the head is something like an eel, but more compressed; the eyes are small, and placed as those of the eel are. In this they are scarce visible. This smallness of the eye betrays an animal that lives so much in mud. The nostrils are very plainly to be distinguished; these, with the gills, and remarkable length of the lungs, shew it to be a true amphibious animal. The mouth is small in proportion to the length of the body; but its palate and inside of the lower jaw (see fig. C.) are well provided with many rows of pointed teeth: with this provision of nature, added to the sharp exterior bony edges of both the upper and under jaw, the animal seems capable of biting and grinding the hardest kind of food. The skin, which is black, and full of small scales, resembles shagreen. These scales are of different sizes and shapes, according to their situation; but all appear sunk into its gelatinous surface: those along the back and belly are of an oblong oval form, and close set together; in the other parts they are round, and more distinct. Both the sides are mottled with small white spots, and have two distinct lines composed of small white streaks continued along from the feet to the tail. The fin of the tail has no rays, and is no more than an adipose membrane like that of the eel; this fin appears more distinctly in the dry animal than in those that have been preserved in spirits.

"The opercula, or coverings to the gills, in dry specimens, appear shrivelled up; but yet we may plainly see that they have been doubly pennated. Under these coverings are the openings to the gills, three on each side, agreeable to the number of the opercula. In the plate, at fig. F. the fins are represented as they appear when just taken out of the water and put into the spirits of wine.

"The form of these pennated coverings approach very near to what I have some time ago observed in the larva, or aquatic state of our English lacerta, known by the name of *est* or *water-newt*, (see fig. D and E), which serve them for coverings to their gills, and for

fins to swim with during this state; and which they lose, as well as the fins of their tails, when they change and become land-animals; as I have observed by keeping them alive for some time myself.

"Recollecting these observations on the changes of our lizard, and at the same time the many remarkable changes in frogs, I began to suspect whether this animal might not be the larva state of some large kind of lizard; and therefore requested the favour of Dr So-lander to examine with me the lacertas in the British Museum, that we might see whether any of the young ones had only two feet; but after carefully going thro' many kinds, we could plainly discover four feet perfectly formed, even in those that were but just coming out of their eggs.

"During this state of uncertainty, I forwarded to Dr Linnæus of Upsal, at Dr Garden's request, his account of the largest specimen, and at the same time sent him one of the smaller specimens preserved in spirits; desiring his opinion, for my own as well as Dr Garden's satisfaction.

"About the end of January last I was favoured with an answer from the professor, dated Upsal, Dec. 27th 1765; wherein he says,

"I received Dr Garden's very rare two-footed animal with gills and lungs. The animal is probably the larva of some kind of lacerta, which I very much desire that he will particularly inquire into. If it does not undergo a change, it belongs to the order of nantes, which have both lungs and gills; and if so, it must be a new and very distinct genus, and should most properly have the name of *fin*. I cannot possibly describe to you how much this two-footed animal has exercised my thoughts; if it is a larva, he will no doubt find some of them with four feet. It is not an easy matter to reconcile it to the larva of the lizard tribe, its fingers being furnished with claws; all the larvas of lizards that I know are without them, (*digitis muticis*). Then, also the branchiæ, or gills, are not to be met with in the aquatic salamanders, which are probably the larvas of lizards. Further, the croaking noise or sound it makes, does not agree with the larvas of those animals; nor does the situation of the anus. So that there is no creature that ever I saw, that I long so much to be convinced of the truth, as what this will certainly turn out to be.

"P. S. In a letter lately received from Dr Garden, he mentions one remarkable property of this animal, which is, that his servant endeavouring to kill one of them by dashing it against the stones, it broke into three or four pieces: he further says, that he has had an opportunity of seeing many of them lately of a much larger size, and that he never saw one with more than two feet; so that he is fully convinced that it is quite a new genus of the animal-kingdom."

MUFFLE, in chemistry, a vessel much used in some metallurgic operations. In figure it represents an oblong arch or vault, the hinder part of which is closed by a semicircular plane, and the lower part, or floor of which, is a rectangular plane. It is a little oven that is placed horizontally in assay and enamelling furnaces, so that its open side corresponds with the door of the fire-place of the furnace. Under this arched oven small cupels, or crucibles, are placed; and the substances contained are thus exposed to heat without con-

Mod.  
Muffle.

Mufti  
||  
Mugi.

tack of fuel, smoke, or ashes.

MUFFI, the chief of the ecclesiastical order, or primate of the mussulman religion. The authority of the mufti is very great in the Ottoman empire; for even the sultan himself, if he would preserve any appearance of religion, cannot, without hearing his opinion, put any person to death, or so much as inflict any corporal punishment. In all actions, especially criminal ones, his opinion is required, by giving him a writing in which the case is stated under feigned names; which he subscribes with the words, *He shall, or, Shall not be punished*. Such outward honour is paid to the mufti, that the grand signior himself rises up to him, and advances seven steps to meet him when he comes into his presence. He alone has the honour of kissing the sultan's left shoulder, whilst the prime vizier kisses only the hem of his garment. When the grand signior addresses any writing to the mufti, he gives him the following titles: *To the esad, the wisest of the wise, instructed in all knowledge, the most excellent of excellents, abstaining from things unlawful, the spring of virtue and of true science, heir of the prophetic doctrines, resolver of the problems of faith, revealer of the orthodox articles, key of the treasures of truth, the light to the doubtful allegories, strengthened with the grace of the supreme Legislator of mankind, may the Most High God perpetuate thy virtues!* The election of the mufti is solely in the grand signior, who presents him with a vest of rich fables, &c. If he is convicted of treason, or any great crime, he is put into a mortar kept for that purpose in the Seven Towers at Constantinople, and pounded to death.

MUGGLETONIANS, a religious sect which arose in England about the year 1657; so denominated from their leader Lodowick Muggleton, a journeyman-taylor, who, with his associate Reeves, set up for great prophets, pretending, as it is said, to have an absolute power of saving and damning whom they pleased; and giving out that they were the two last witnesses of God that should appear before the end of the world.

MUGIL, the MULLER; in ichthyology, a genus of fishes belonging to the order of abdominales. The lips are membranaceous, the inferior one being carinated inwards; they have no teeth; the branchiostege membrane has seven crooked rays; the opercula are smooth and round; and the body is of a whitish colour. There are two species, distinguished by the number of rays in the back-fin.

The mullet is justly ranked by Aristotle among the *pisces littorales*, or those that prefer the shores to the full sea; they are found in great plenty on several of the sandy coasts of our island, and haunt in particular those small bays that have influxes of fresh water. They come in great shoals, and keep rooting like hogs in the sand or mud, leaving their traces in form of large round holes. They are very cunning; and when surrounded with a net, the whole shoal frequently escapes by leaping over it; for when one takes the lead, the others are sure to follow. This circumstance is observed by Oppian; who also informs us, that if these fishes fail to get over at the first leap, they never attempt a second, but lie without motion as if they resigned themselves to their fate. Mr Pennant says he is uncertain whether this last observation holds good or not; however, Oppian had good opportunity of exa-

mining those fish, as they sometimes swarm on the coasts of the Mediterranean. Near Martegues, in the south of France, abundance of mullets are taken in wares made of reeds placed in the shallows. Of the milts of the males, which are there called *allestante*, and of the roes of females, which are called *botar*, is made botargo. The materials are taken out entire, covered with salt for four or five hours, then pressed a little between two boards or stones, washed, and at last dried in the sun for 13 or 14 days.

This fish was sometimes made the instrument of a horrible punishment for unfortunate gallants. It was used both at Athens and Rome; but it is very doubtful whether it was a legal punishment or not. By Horace it is mentioned in the following lines:

*Difcineta tunica fugiendam est, et pede nudo;*

*Nec nummi percant, aut Præga, aut desque fama.*

Satyr. II. lib. i. r32.

The mullet is an excellent fish for the table, but at present not a fashionable one.

MUGWORT, in botany, a species of ARTEMISIA. An infusion of this plant in white wine, or a bath made of it, has been always esteemed an emmenagogue, and useful in difficult parturition. The leaves, when young and tender, are frequently made use of by the Highlanders of Scotland as a pot-herb. The country-people in Sweden drink a decoction of them for the ægue.

MUID, a large measure in use among the French, for things dry. The muid is no real vessel used as a measure, but an estimation of several other measures; as the septier, mine, minot, bushel, &c.

MUID, is also one of the nine casks, or regular vessels used in France, to put wine and other liquors in. The muid of wine is divided into two demi-muids, four quarter muids, and eight half-quarter muids, containing 36 septiers.

MULATTO, a name given in the Indies to those who are begotten by a negro man on an Indian woman, or by an Indian man on a negro woman.

MULBERRY, in botany. See MORUS.

MULCT, a fine of money laid upon a man who has committed some fault or misdemeanour.

MULE, in zoology, a mongrel kind of quadruped, usually generated between an ass and a mare, and sometimes between a horse and a she-ass; but the signification of the word is commonly extended to every kind of animal produced by a mixture of two different species. There are two kinds of these animals; one from the he-ass and mare, the other from the horse and the she-ass. We call them indifferently *mules*, but the Romans distinguished them by proper appellations. The first kind are the best and most esteemed; as being larger, stronger, and having least of the ass in their disposition. The largest and stoutest asses, and the fairest and finest mares, are chosen in those countries where these creatures are most in use; as in Spain, Italy, and Flanders. In the last especially, they succeeded in having very stately mules from the size of their mares, some of them 16, and some 17 hands high, which are very serviceable as sumpter-mules in the army. But, since the Low Countries are no longer under the dominion of Spain, they breed fewer mules. These creatures are very much commended for their being stronger, surer footed, going easier, being more cheaply maintained,

Mugwort  
||  
Mule.

tained, and lasting longer than horses. They are commonly of a black-brown, or quite black, with that shining lilt along the back and crofs the shoulders, which distinguishes asses. In former times they were much more common in this country than at present; being often brought over in the days of Popery by the Italian prelates. They continued longest in the service of millers; and are yet in use among them in some places, on account of the great loads they carry on their back. As they are capable of being trained for riding, bearing burdens, and for draught, there is no doubt that they might be usefully employed in many different services. But they are commonly found to be vicious, stubborn, and obstinate to a proverb; which whether it occasions or is produced by the ill usage they meet with, is a point not easily settled. Whatever may be the case of asses, it is allowed that mules are larger, fairer, and more servicable in mild than in warm climates. In the British American colonies, both on the continent and in the islands, but especially in the latter, they are much used and esteemed; so that they are frequently sent to them from hence, suffer less in the passage, and die much seldomer than horses, and commonly yield, when they arrive, no inconsiderable profit.

It hath commonly been asserted, that animals produced by the mixture of two heterogeneous species, are incapable of generating, and thus perpetuating the monstrous breed; but this, we are informed by M. Buffon, is now discovered to be a mistake. Aristotle, says he, tells us, that the mule engenders with the mare, and that the junction produces an animal which the Greeks call *hinus*, or *ginnus*. He likewise remarks, that the she-mule easily conceives, but seldom brings the fetus to perfection. But the most remarkable and well attested instance of this fact, is mentioned in a letter read by M. d'Alambert before the academy of sciences, which informed him that a she-mule in the island of St Domingo had brought forth a foal. The fact was attested by persons of the most unquestionable veracity; and other instances, though not so well authenticated, are adduced by our author. We may therefore, continues M. Buffon, consider it as an established fact, that the he-mule can generate, and the she-mule produce. Like other animals, they have a feminal liquor, and all the organs necessary to generation. But mongrel animals are always less fertile and more tardy than those of a pure species. Besides, mules have never produced in cold climates, seldom in warm regions, and still more seldom in temperate countries. Hence their barrenness, without being absolute, may be regarded as positive; since their productions are so rare, that a few examples can be only collected.

The translator of Buffon's works, in a note on the passage above-quoted, hath given a remarkable and well authenticated instance of the prolific powers of a she-mule in the north of Scotland. Having heard that a mule, belonging to Mr David Tullo farmer in Auchtertyre, in the county of Forfar, had some years ago brought forth a foal, he transmitted a few queries to be put to Mr Tullo; and requested that his answers might be legally attested before a magistrate. This request was cheerfully complied with; and the following is an exact copy of the queries, answers, and at-

testations.

Interrogatories to be put to Mr Tullo tenant in Auchtertyre, parish of Newtyle, and county of Forfar, with his answers thereto.

1mo, Had you ever a she-mule? At what period? Is it true that the mule had a foal? At what time was she covered; and when did the foal?

Answered by Mr Tullo: That he bought a she-mule about 20 years ago: That she was constantly in season for a horse: That, about some years thereafter, he gave her a horse; and that she thereafter gave him a foal, about the 10th of June. The mule's price was 4*l.* 5*s.* Sterling.

2do, What was the colour of the foal? Was there any thing particular in its figure?

Answer: The foal was exactly the colour of its mother, inclined to black, with a very large head, big ears, and small tail; and the declarant thinks, had its head been weighed when foaled, it would have weighed nearly as much as its body.

3tio, How long was the animal allowed to live?

Answer: The next day after the mule foaled, it was sent, with its mother, to the Loch of Lundie, in order to let the foal die, as the declarant could not want the mule's work, and the mother seemed not fond of the foal: That it was accordingly left, and next day came to Auchtertyre, about two miles distance, over a hill, with the cattle of Auchtertyre, that had been grazing near to that place, and was drowned in a ditch the day following.

4to, Was its skin preserved, or the head, or any other bones of the skeleton? Could any part thereof be fill found?

Answered: Neither the skin, nor any part of the skeleton was preserved, nor can now be had; though the declarant has often regretted the not preserving the foal, as its mother always performed any work that a horse of 15*l.* value could do.

5to, Is the mother still alive? What is her age?

Answer: The mother died about eight years ago, of an epidemic cold that was raging among the horses in this country: The mule had little or no milk after foaling, and the foal got some cow's milk: And this is all that he remembers of the matter. DAVID TULLO.

Auchtertyre, 4th February 1780.

We James Small tenant in Burmouth, and Robert Ramsay tenant in Newtyle, hereby certify, That we have often seen the mule above described; and we know that she had a foal, as is narrated by David Tullo.

JAMES SMALL. ROB. RAMSAY.

Ballantyne house, 4th February 1780.

The within interrogatories were put to David Tullo tenant in Auchtertyre, aent he mule he had, and the foal she produced; to which he gave the answers subjoined to each query, and signed them; as did James Small and Robert Ramsay, attesting the truth thereof, in presence of

GEORGE WATSON, J. P.

The original attestation is in the possession of the translator; and he lately transmitted notarial or authenticated copies of it to the count de Buffon, and to Thomas Pennant, Esq; of Downing, in Flintshire.

MULIER, in law, signifies the lawful issue born in wedlock, though begotten before. The mulier is pre-

Mull  
f  
Mullus.

preferred to an elder brother born out of matrimony; as for instance, if a man has a son by a woman before marriage, which issue is a bastard, and afterwards marries the mother of the bastard, and they have another son, this second son is mulier and lawful, and shall be heir of the father; but the other can be heir to no person †. By the civil law, where a man has issue by a woman, if after that he marries her, the issue is mulier.

† See the article *Bastard*.

MULL, one of the Western Islands of Scotland, about 24 Scots miles long, and as much in breadth. It is in general rocky and barren, not producing a sufficient quantity of corn for the inhabitants; but about 1800 head of cattle are annually exported. The island was originally part of the dominions of the Lords of the Isles; but in after-times it became part of the possessions of the ancient and valiant family of Macleanes, who still retain one-half. The other is the litigated property of the duke of Argyle, whose ancestor possessed himself of it in 1674, on account of a debt; but after the courts of law had made an adjudication in his favour, he was obliged to support their decree by force of arms.

MULL of *Cantire*, the south cape or promontory of the county of Cantire or Mull, in the frith of Clyde, in the west of Scotland.

MULL of *Galloway*, the south cape or promontory of all Scotland, in the county of Galloway, on the Irish Sea.

MULLER, or REGIOMONTANUS (John), a celebrated astronomer of the 15th century, was born at Koningshoven in Franconia in 1436, and acquired great reputation by publishing an abridgment of Ptolemy's *Almagest*, which had been begun by Purback. He went to Rome to perfect himself in the Greek tongue, and to see the cardinal Bassarion; but finding some faults in the Latin translations of George de Trebizond, that translator's son assassinated him in a second journey he made to Rome in 1476, where Pope Sixtus IV. had provided for him the archbishopric of Ratibon, and had sent for him to reform the calendar. Others say that he died of the plague.

MULLERAS, a town of Germany, in the circle of Upper Saxony, and marquise of Brandenburg, seated 38 miles south of Berlin, upon a canal which joins the Oder and the Spree. This canal is 15 miles in length, 10 yards in breadth, and seven feet in depth. It was eight years in making; and since that time the cities of Hamburg and Breslaw have carried on great trade by water. E. Long. 14. 50. N. Lat. 52. 21.

MULLET, in ichthyology. See MUGIL.

MULLET, or *Mollet*, in heraldry, a bearing in form of the rowel of a spur, which it originally represented. See Plate CXLIV.

MULLUS, in ichthyology, a genus of fishes belonging to the order of thoracici. The *barbatus*, or red furrullet, was highly esteemed by the Romans, and bore an exceeding high price. The capricious epicures of Horace's days valued it in proportion to its size; not that the larger were more delicious, but that they were more difficult to be got. The price that was given for one in the time of Ju-

venal and Pliny, is a striking evidence of the luxury and extravagance of the age:

Mullum sex millibus erit  
Æquantem sane paribus sestertia libris †. JUV. Sat. IV.  
The lavish slave  
Six thousand pieces for a mullet gave,  
A fetterce for each pound.

Mullus  
f  
Mullipica-  
tus.

‡ 48 l. 8 s.  
9 d.

DRYDEN.

But Añnius Celer, a man of consular dignity, gave a still more unconscionable sum; for he did not scruple bestowing 8000 *nummi*, or 64 l. 11 s. 8 d. for a fish of so small a size as the mullet: for, according to Horace, a *mullus trilibris*, or one of 3 lb. was a great rarity; so that Juvenal's spark must have had a great bargain in comparison of what Celer had.

But Seneca says, that it was not worth a farthing except it died in the very hand of your guest: that such was the luxury of the times, that there were stewes even in the eating-rooms, so that the fish could at once be brought from under the table, and placed on it: that they put the mullets in transparent vases, that they might be entertained with the various changes of its rich colour while it lay expiring. Apicius, a wonderful genius for luxurious inventions, first hit upon the method of suffocating them in the exquisite Carthaginian pickle, and afterwards procured a rich sauce from their livers. This is the same gentleman whom Pliny, in another place, honours with the title of *Nepotam omnium altissimus gurgis*; an expression too forcible to be rendered in our language.

Mr Pennant has heard of this species being taken on the coast of Scotland, but had no opportunity of examining it; and whether it is found in the west of England with the other species or variety, we are not at this time informed. Salviaus makes it a distinct species, and says that it is of a purple colour, striped with golden lines, and that it did not commonly exceed a palm in length: no wonder then that such a prodigy as one of 6 lb. should so captivate the fancy of the Roman epicure.

Mr Ray establishes some other distinctions, such as the first dorsal fin having nine rays, and the colour of that fin, the tail, and the pectoral fins, being of a very pale purple.

MULTIPLE, in arithmetic, a number which comprehends some other several times: thus 6 is a multiple of 2, and 12 is a multiple of 6, 4, and 3; comprehending the first twice, the second thrice, &c.

ACTION of MULTIPLEPOINDING, in Scots law. See LAW, n° clxxxiii. 24.

MULTIPLICAND, in arithmetic, the number to be multiplied by another. See there, n° 10.

MULTIPLICATION, in general, the act of increasing the number of any thing.

MULTIPLICATION, in arithmetic, is a rule by which any given number may be speedily increased, according to any proposed number of times \*.

MULTIPLICATION, in algebra. See ALGEBRA, n° 5. *Arithmetica*, n° 10.

MULTIPLICATOR, or MULTIPLIER, in arithmetic, the number by which any other is multiplied, or the number of times it is supposed to be taken. See ARITHMETIC, n° 10.

MULTIPLICATUS FLOS, a luxuriant flower, whose petals are multiplied so as to exclude a part of the stamina.

\* See

Multiplic-  
tus  
Mum.

A multiplied luxuriant flower differs from a full one, the highest degree of luxuriance, in that the petals of the latter are fo multiplied as to exclude all the stamina : whereas thofe of the former are only repeated or multiplied, two, three, or four times, as to the exclusion of only a fmall part of the effential organs.

MULTIPLYING-GLASS, in optics, a glafs where-with objects appear increafed in number. See (the *Index* fubjoined) to OPTICS.

MULTURE, in Scots law, the quantity of grain paid to the proprietor or tackfman of a mill, for grinding.

MULVIA, a river of Barbary in Africa, which rifes in the mountains of Atlas, and divides the empire of Morocco from that of Algiers, and then falls into the Mediterranean, to the weftward of Marfalquiver.

MUM, a kind of malt-liquor much drank in Germany, and chiefly brought from Brunfwick, which is the place of moft note for making it. The procefs of brewing mum, as recorded in the town-houfe of that city, is as follows : Take 63 gallons of water that has been boiled till one-third part is confumed, and brew it with feven bufhels of wheaten malt, one bufhel of oat-meal, and one bufhel of ground beans. When it is tunned, the hoghead muft not be filled too full at firft : as foon as it begins to work, put into it three pounds of the inner rind of fir, one pound of the tops of fir and beach, three handfuls of *cardus benedictus*, a handful or two of the flower of *rosa folis* : add burnet, betony, marjoram, aveys, pennyroyal, and wild thyme, of each an handful ahd an half ; of elder-flowers, two handfuls or more ; feeds of cardamom bruifed, 30 ounces ; barberries bruifed, one ounce : when the liquor has worked a while, put the herbs and feeds into the vefel ; and, after they are added, let it work over as little as poffible ; then fill it up : laftly, when it is flopped, put into the hoghead ten new-laid eggs unbroken ; flop it up clofe, and ufe it at two years end. The brewers of this country, inftead of the inner rind of fir, ufe cardamom, ginger, and fafafras ; and alfo add elicampane, madder, and red fandlers. Mum, on being imported, pays for every barrel 1 l. 5 s.

MUMMY, a body embalmed or dried, in the manner ufed by the ancient Egyptians ; or the compofition with which it is embalmed. There are two kinds of bodies denominated *mummies*. The firft are only carcafes dried by the heat of the fun, and by that means kept from putrefaction : thefe are frequently found in the fands of Libya. Some imagine, that thefe are the bodies of deceafed people buried there on purpofe to keep them entire without embalming ; others think they are the carcafes of travellers, who have been overwhelmed by the clouds of fand raifed by the hurricanes frequent in thofe defarts. The fecond kind of mummies are bodies taken out of the catacombs near Cairo, in which the Egyptians depofited their dead after embalming. See EMBALMING.

We have two different fubftances preferved for medicinal ufe under the name of *mummy*, though both in fome degree of the fame origin. The one is the dried and preferved fleft of human bodies, embalmed with myrrh and fpecies ; the other is the liquor running from fuch mummies, when newly prepared, or when affected by great heat or damp. The latter is fome-

times in a liquid, fometimes of a folid form, as it is preferved in vials well flopped, or fuffered to dry and harden in the air. The firft kind of mummy is brought to us in large pieces, of a lax and friable texture, light and fpongy, of a blackifh brown colour, and often damp and clammy on the furface : it is of a ftrong but difagreeable fmell. The fecond kind of mummy, in its liquid ftate, is a thick, opaque, and viscus fluid, of a blackifh colour, but not difagreeable fmell. In its indurated ftate, it is a dry folid fubftance, of a fine fhining black colour, and clofe texture, eafily broken, and of a good fmell ; very inflammable, and yielding a fcent of myrrh and aromatic ingredients while burning. This, if we cannot be content without medicines from our own bodies, ought to be the mummy ufed in the fhops ; but it is very fcarce and dear ; while the other is fo cheap, that it will always be moft in ufe.

All thefe kinds of mummies are brought from Egypt. But we are not to imagine, that any body breaks up the real Egyptian mummies, to fell them in pieces to the druggifts, as they make a much better market of them in Europe whole, when they can contrive to get them. What our druggifts are fupplied with, is the fleft of executed criminals, or of any other bodies the Jews can get, who fill them with the common bitumen, fo plentiful in that part of the world ; and adding a little aloes, and two or three other cheap ingredients, fend them to be baked in an oven, till the juices are exhale, and the embalming matter has penetrated fo thoroughly that the fleft will keep and bear tranfporting into Europe. Mummy has been efteemed refolvent and balfamic ; but whatever virtues have been attributed to it, feem to be fuch as depend more upon the ingredients ufed in preparing the fleft, than in the fleft itfelf ; and it would furely be better to give thofe ingredients without fo fhocking an addition.

MUMMV, among gardeners, a kind of wax ufed in grafting and planting the roots of trees, made in the following manner : Take one pound of black pitch, and a quarter of pound of turpentine ; put them together into an earthen pot, and fet them on fire in the open air, holding fomething in your hand to cover and quench the mixture in time, which is to be alternately lighted and quenched till all the nitrous and volatile parts be evaporated. To this a little common wax is to be added ; and the compofition is then to be fet by for ufe.

MUMPS. See MEDICINE, n<sup>o</sup> 526.

MUNDA, an ancient town of Spain, in the kingdom of Granada, feated on the declivity of a hill, at the bottom of which runs a river. W. Long. 4. 13. N. Lat. 48. 15.

MUNICH, a town of Germany, capital of the whole duchy of Bavaria, and the refidence of the elector. It ftands on the Ifar, 70 miles fouth of Ratifbon, and 214 weft of Vienna, being one of the moft pleafant and populous cities of Germany for its bignefs. The number of the inhabitants is faid to be about 40,000. Having been built at firft on a fpot of ground belonging to a convent, it had from thence, in German, the name of *Muncken*, i. e. *Monks's-town*, and a monk for its arms. The elector's place here is a very grand ftructure, confifting of feveral courts, fur-

Mummy  
Munich.

Munich,  
Municipal.

furnished and adorned in the most magnificent manner, with tapestry, gilding, sculpture, statues, and paintings. It contains an amazing collection of jewels, antiquities, and curiosities. The great hall is 118 feet long, and 52 broad; and the fair-case leading to it, from top to bottom, of marble and gold. In the hall of antiquities are 354 busts and statues of jasper and porphyry, brass and marble. In this palace also is a library, containing a vast collection of books, and many valuable manuscripts, in most languages, ancient and modern; and a chamber of rarities, among which is the picture of a bravo, or assassin, who is said to have committed 345 murders with his own hand, and to have been accomplice in, or privy to, 400 more. The treasury in the chapel contains also a vast number of pictures, precious stones, medals, vessels of gold and silver, &c. Among other curiosities, here is a cherry-stone with 140 heads distinctly engraved upon it. The gardens of the palace are also very fine, and it is said a secret passage leads from it to all the churches and convents in the town. There is a great number of other fine buildings in this city, public and private, particularly the riding-house, town-house, opera-room, the Jesuits college, the large edifice for tournaments, the churches, convents, fountains, &c. Its manufactures are those of silk, particularly velvet, woollen cloths, and tapestry; and it has two annual fairs, at which great quantities of salt, wine, &c. are sold. The streets are broad and regular; and most of the houses well built, and painted on the outside. The market-place is extremely beautiful. Mr Keyser says, the servant-maids at the great inns here, on holidays, wear a silver chain round their necks, consisting of three rows; and that their breasts are likewise laced with two other chains of the same metal. He further observed, that it was a general custom to place a green garland, on a bundle of straw, before every house containing the corpse of an unmarried person. The common salutation here, and in the other catholic countries of Germany, is, *Praised be Jesus Christ*; and the answer returned, *For ever amen*: two popes having granted an indulgence of 100 days each time to all that use it. Not far from Munich are four other palaces, with fine gardens, belonging to the elector, viz. those of Schleisheim, Nymphenburg, Dauchau, and Starenberg. The first and last are about three leagues from the capital; the second about half a league; and the third about two, at a market-town of the same name.

**MUNICIPAL**, in the Roman civil law, an epithet which signifies invested with the rights and privileges of Roman citizens. Thus the municipal cities were those whose inhabitants were capable of enjoying civil offices in the city of Rome: these cities, however, according to Mariana, had fewer privileges than the colonies; they had no suffrages or votes at Rome, but were left to be governed by their own laws and magistrates. Some few municipal cities, however, obtained the liberty of votes.

**MUNICIPAL**, among us, is applied to the laws that obtain in any particular city or province. And those are called *municipal officers* who are elected to defend the interest of cities, to maintain their rights and privileges, and to preserve order and harmony among the citizens; such as mayors, sheriffs, consuls, &c.

**MUNITION**, the provisions with which a place is furnished, in order for defence; or that which follows a camp for its subsistence.

Munition,  
Munitioner.

**MUNITION Ships**, are those that have stores on board in order to supply a fleet of men of war at sea. In an engagement, all the munition-ships and victuallers attending the fleet take their station in the rear of all the rest; they are not to engage in the fight, but to attend such directions as are sent them by the admiral.

**MUNSTER** (Sebastian), a learned writer, was born at Ingelheim, and became a cordelier; but having embraced Luther's sentiments, he quitted that order in 1529, and retired to Heidelberg, and afterwards to Basil, where he taught with reputation. He was a man of great candour, and void of ambition; and was so well skilled in geography, the mathematics, and the Hebrew tongue, that he was furnished the *Ejtras* and the *Strabo of Germany*. His Latin translation of the bible is esteemed. He was the first who wrote a Chaldee grammar and lexicon: he also published a treatise on cosmography, and several other works. He died of the plague at Basil in 1552, aged 63.

**MUNSTER**, in Latin *Mononia*, and in Irish *Moun*, the most southerly province of Ireland; bounded on the south by the Vergivian sea, on the west by the Atlantic ocean, on the north by the river Shannon which parts it from Connaught, and on the east by the Irish sea. Its length is about 130 miles; but its breadth is very unequal, being from 68 miles to 120. The air is healthful and temperate; and the soil, where properly cultivated, is fruitful both in corn and grass; but the mountains are bleak and barren. The northern parts, being the most level and fertile, are the best improved and inclosed. Vast numbers of cattle are fed in the province; which is also well supplied with fish, especially cod and herrings.

**MUNSTER**, a territory of Germany, in the circle of Westphalia; bounded on the north by Embden and Oldenburg, on the south by the county of Mark and duchy of Westphalia, on the west by the county of Bentheim and the United Provinces, and on the east by the bishoprics of Osnaburg and Paderborn together with the county of Ravensberg. It is the largest of all the Westphalian bishoprics, being in length about 80 miles, and in breadth from 20 to 60. It is divided into 13 bailiwicks; and tho' in general but a barren country, has some fruitful plains, with woods, and quarries of stone. The inhabitants, excepting a few of the nobility and gentry, are all Roman Catholics; though Lutheranism had once a considerable footing here. The bishop, who is generally also elector of Cologne, has a revenue from hence of about 70,000 pounds, and can maintain 8000 men. In consequence of an unjust custom, unknown in the rest of the empire, he is heir to all strangers who die in the country without children. In the matricula he is rated at 30 foot, and 118 horse; or 832 florins monthly in lieu of them. His chapter consists of 40 canons, who are all noble.

**MUNSTER**, a city of Germany, capital of a bishopric of the same name and of all Westphalia, stands at the conflux of the river Aa with the Ems, in E. Long. 7. 49. N. Lat. 52. 0. It is of a circular form.

Munychia, form, large, and well fortified both by nature and art. Muræna.

It hath a fine citadel called the *Brille*, erected by a bishop named *Bernard van Galen* in order to awe the burghers. The dean and chapter now elect the bishop; but till the beginning of the 13th century he was nominated by the emperor. This city has been rendered famous by three remarkable transactions. 1. By the peace concluded here in 1648, which put an end to a war of 30 years; occasioned by the persecuting spirit of bigotted papists, who chose rather to plunge their country into all the calamities of war than allow liberty of conscience to the Protestants. By this peace, however, they consented, much against their inclinations, to grant them a toleration. 2. By the disorders and disturbances occasioned here in 1553, by a parcel of enthusiasts called the *Munster Anabaptists*, who, headed by a taylor, called *John of Leyden*, from the place of his birth, turned out the magistrates, and took possession of the city, where they perpetrated the most horrid villanies and cruelties. 3. For the noble, though unsuccessful, efforts it made in defence of its liberties against the tyranny and usurpation of the above-mentioned turbulent and bloody-minded bishop, *Bernard van Galen*. In this city are a great number of convents, and other religious houses, many of them stately piles, and surrounded with beautiful gardens.

MUNYCHIA, or *Munychiaus Portus*, (anc. geogr.) a village and port of Athens, nearer to the city, less than and fortified in the same manner with the Piræus, to the east of which it lay, or between it and the promontory Sunium, at the mouth of the Ilissus. Strabo says it was an eminence in form of a peninsula, at the foot of which stood three harbours, anciently encompassed with a wall, taking within its extent the Piræus and other harbours, full of docks, with the temple of Diana *Munychia*, (*Pausanias*); taking its name from *Mynichus*, the founder of the temple, (*Strabo*, *Plutarch*).

MURÆNA, or EEL, in ichthyology; a genus of fishes, belonging to the order of apodes. The head is smooth; there are ten rays in the membrane of the gills; the eyes are covered with a common skin; and the body is cylindrical and slimy. There are seven species, distinguished by their fins, tail, &c. The most remarkable are,

1. The *anguilla*, or common eel, is very frequent in all our fresh waters, ponds, ditches, and rivers: according to Mr Pennant, it is the most universal of fish, yet is scarce ever found in the Danube, though very common in the lakes and rivers of Upper Austria.

The eel is very singular in many things relating to its natural history, and in some respects borders on the nature of the reptile tribe. It is known to quit its element, and during night to wander along the meadows, not only in order to change its habitation, but also for the sake of prey, feeding on snails as it passes along. During winter it beds itself deep in the mud, and continues in a state like the serpent-kind. It is very impatient of cold, and will eagerly take shelter in a wisp of straw flung into a pond in severe weather, which has sometimes been practised as a method of taking them. *Albertus* affirms, that he has known eels to take shelter in a hay-rick; yet all perished through excess of cold.

It has been observed in a river of England called the *Nyne*, there is a variety of small eel, with a leffer head and narrower mouth than the common kind, that is found in clusters in the bottom of the river, and is called the *bed-eel*: these are sometimes roufed up by the violent floods, and are never found at that time with meat in their stomach.

There is scarce any animal the generation of which has puzzled the learned more than this. Aristotle first broached an opinion that eels were of no sex, nor did propagate their species like other animals, but were equivocally gendered of the mud; and as wild and absurd a system as this is, there have not been wanting many, even in these latter and more enlightened times, who have given into it. But there is now no room to doubt that all animals are produced by the copulation of parents like themselves; and the finding of eels in new ponds is easily accounted for from the above-mentioned circumstance of their migration. Dr Plot, and many others, have given accounts of whole droves of them leaving one ditch or pond to go to another.

Though the learned world at this time generally allows that eels are produced like other animals, by parents of their own kind, yet there remain many doubts about the manner in which the generation is performed. Some allow the eels to be, like the generality of other animals, of different sexes in the different individuals; and others affirming that they are all hermaphrodites, each having the parts of generation of both sexes. *Rondeletius* affirms that they are of both sexes; and Mr Allan, who has given a very curious paper concerning them in the *Philosophical Transactions*, is of the same opinion; and both say, that the parts of the sexes may be discovered on a careful inspection; and some are found to be males, and others females; but these parts are, in both sexes, they say, buried in a large quantity of fat; and they are of opinion, that hence proceeded the mistake of Aristotle and his followers, who, not being able to find those parts, concluded that they did not exist at all. Among those who allow the eel to be produced, like other animals, from animal-parents which have the sexes, some are of opinion that they are viviparous, and others that they are oviparous: but Mr *Chartrwynd* seems to have determined this controversy by observing, that if the aperture under the belly of the eel, which looks red in the month of May, be cut open at that time, the young eels will be seen to come forth alive after the operation. Mr *Leuwenhoeck* says, that he found an uterus in every eel he examined; and therefore concludes, that they are hermaphrodites: and he supposes that they have no male parts of generation like those of other animals; but that the office of these is performed by a liquor analogous to the male seed of animals, which is contained in certain glands, situated on the inside of the uterus itself.

Eels have sometimes been met with in recent ponds, made at such a distance from any other water that we cannot reasonably suppose them to have migrated thither over land. But in these cases there is reason to believe, that the ponds have been supplied with them by the aquatic fowl of prey, in the same manner as vegetation is spread by many of the land-birds,

Morzua.

either by being dropped, as they carry them to feed their young, or by passing quick through their bodies, as is the case with herons.

These fish are extremely voracious, and destructive to the fry of others. No fish lives so long out of water as the eel; and it is extremely tenacious of life, inasmuch that its parts will move a considerable time after they are flayed and cut in pieces. They vary much in their colours, from a footy hue to a light olive green; and those which are called *flower eels* have their bellies white, and a remarkable clearness throughout.

Besides these, there is a variety of this fish known in the river Thames by the name of *grigs*, and about Oxford by that of *grigs* or *gluts*. These are scarce ever seen near Oxford in the winter; but appear in spring, and bite readily at the hook, which common eels in that neighbourhood will not. They have a larger head, a blunter nose, thicker skin, and less fat, than the common sort; neither are they so much esteemed, nor do they often exceed three or four pounds in weight.—Common eels grow to a large size, sometimes weighing 15 or 20 pounds; but that is extremely rare. Mr Dale indeed, in the Philosophical Transactions, and some others, bring instances of eels much exceeding that size; but Mr Pennant suspects them to have been congers, since the enormous fish they describe have all been taken at the mouths of the Thames or Medway. The Romans held eels very cheap, probably on account of their likeness to snakes. On the contrary, the luxurious Sybarites were so fond of these fish, as to exempt from tribute of every kind those persons who sold them.

2. The *conger*, or conger-eel, grows to a vast size. Dr Borlase informs us, that they are sometimes taken near Mount's-bay of 100 lb. weight; and Mr Pennant assures us, that he has heard of some taken near Scarborough that were 10 feet and a half long, and 18 inches in circumference in the thickest part.

They differ from the common eel in the following particulars: 1. Their colour in general is more dark. 2. Their eyes much larger in proportion. 3. The irides of a bright silvery colour. 4. The lower jaw is rather shorter than the upper. 5. The side-line is broad, whitish, and marked with a row of small spots. 6. The edges of the dorsal and anal fins are black. 7. They have more bones than the common eel, especially along the back quite to the head. 8. They grow to a much larger size.

As to the distinction that Mr Ray and other writers make of the small beards at the end of the nose, Mr Pennant thinks it not to be depended on, being sometimes found in both kinds, and sometimes entirely wanting.

Probably they generate like the fresh-water species. Innumerable quantities of what are supposed to be their fry, come up the Severn about the month of April, preceding the floods, which it is conjectured migrate into that river to feed on them: they are called *elvers*. They swarm during their season, and are taken in a kind of sieve made of hair-cloth, fixed to a long pole; the fisherman standing on the edge of the water during the tide, puts in his net as far as he can reach, and drawing it out again, takes multitudes

at every sweep, and will take as many during one tide as will fill a bushel. They are dressed, and reckoned very delicate.

Congers are extremely voracious, preying on other fish, and on crabs at the time they have lost their shell and are in a soft state. They and eels in general are also particularly fond of carcases of any kind, being frequently found lodged in such as are accidentally taken up.

These fish are an article of commerce in Cornwall; numbers are taken on that coast, and exported to Spain and Portugal, particularly to Barcelona.

Some are taken by a single hook and line, but (because that way is tedious, and does not answer the expence of time and labour) they are chiefly caught by *bulwers*, which are strong lines 500 feet long, with 60 hooks, each eight feet asunder, baited with pichards or mackarel; the bulwers are sunk to the ground by a stone fastened to them: sometimes such a number of these are tied together as to reach a mile.

The fishermen are very fearful of a large conger, lest it should endanger their legs by clinging round them; they therefore kill them as soon as possible by striking them on the navel.

They are afterwards cured in this manner: They are slit, and hung on a frame till they dry, having a considerable quantity of fat, which it is necessary should exude before they are fit for use. It is remarkable that a conger of 100 weight will waste by drying to 24 lb.; the people therefore prefer the smallest, possibly because they are sooner cured. During the process there is a considerable stench; and it is said, that in the fishing villages the poultry are fed with the maggots that drop from the fish.

The Portuguese and Spaniards use those dried congers after they have been ground into a powder, to thicken and give a relish to their soups. They are sold for about 40 shillings the quintal, which weighs 126 lb.

A fishery of congers, says Mr Pennant, would be of great advantage to the inhabitants of the Hebrides. Perhaps they would at first undertake it with repugnancy, from their absurd aversion to the eel kind.

MURAL crowns. See CROWNS.

MURATORI (Lewis Anthony), a learned and celebrated Italian writer, born at Vignoles, in the territory of Bologna, in 1672. He early discovered an extreme fondness for the learned languages and sciences; and this was seconded by an excellent education. After having completed his first studies, he embraced the state of an ecclesiastic; and applied himself to polite literature, philosophy, theology, civil law, antiquities, and other sciences; by which means he became in a manner universally learned. He was scarce 22 years of age when he was made librarian of the Ambrosian library at Milan. In 1700 the duke of Modena, his sovereign, recalled him, and made him his librarian, and keeper of the archives of his duchy. Muratori discharged this double employment during the rest of his life, and had no other benefice than the provostship of Santa Maria del Poppolo. He acquired the esteem of the learned throughout Europe, who had recourse to him for the lights they wanted. He became an associate to the Academies of the Arcades

Morzua

Muratori.



Murcia,  
Murder.

caedes of Rome, Della Crusca, and Colomberia of Florence, the Academy of Etrusca at Cortona, the Royal Society of London, and of the Imperial Academy of Olmutz; and died in 1750. He wrote a great number of learned works; the principal of which are, 1. *Anecdota*, or a collection of pieces taken from the Ambrosian library, 2 vols 4to. with learned notes and dissertations. 2. A treatise on the perfection of the Italian poetry, 2 vols, 4to. 3. *Anecdota Græca*, 3 vols 4to. 4. *Agenealogical history of the house of Modena*, 2 vols, folio. 5. An excellent collection of the writers of the Italian history, 27 vols folio, with learned notes. 6. Another collection, under the title of *Antiquitates Italicae*. 7. A collection of ancient inscriptions, under the title of *Novus Theaurus*, 6 vols folio. 8. The annals of Italy, 12 vols 4to, in Italian, &c. 9. Letters, dissertations, Italian poems, &c.

MURCIA, the Pagan goddess of idleness.—The name is taken from *murcus* or *murcidus*, an obsolete word, signifying a dull, slothful, or lazy person.—The statues of this goddess were always covered with dust and moss, to express her idleness and negligence. She had a temple in Rome, at the foot of Mount Aventine.

MURCIA, a kingdom in Spain, bounded on the north by New Castile, on the east by the kingdom of Valencia, on the west by Andalusia and Granada, and on the south by the Mediterranean Sea. It is about 62 miles in length, and 58 in breadth; and its principal river is Segura. The soil is dry, because it seldom rains, and therefore it produces little corn or wine; but there is plenty of oranges, citrons, lemons, olives, almonds, mulberries, rice, pulse, and sugar. It has also a great deal of silk. It was taken from the Moors in 1265. The air is very healthful.

MURCIA, a large, handsome, and populous town of Spain, capital of a kingdom of the same name, with a bishop's see. It contains six parishes and a superb cathedral, the stairs of whose steeple are so contrived, that a man may ride up to the top, either on horseback or in a coach. It is situated in a pleasant plain, which abounds in fine gardens about the city, in which are the best fruits in Spain. It is seated on the river Segura, in W. Long. c. 36. N. Lat. 37. 48.

MURDER, or MURTHUR, in law, is thus defined, or rather described, by Sir Edward Coke: "when a person, of sound memory and discretion, unlawfully killeth any reasonable creature in being, and under the king's peace, with malice aforethought, either express or implied." The best way of examining the nature of this crime will be by considering the several branches of this definition.

1. It must be committed by a person of sound memory and discretion: for lunatics or infants are incapable of committing any crime; unless in such cases where they shew a consciousness of doing wrong, and of course a discretion, or discernment between good and evil.

2. Next, it happens when a person of such sound discretion unlawfully killeth. The unlawfulness arises from the killing without warrant or excuse: and there must also be an actual killing to constitute murder; for a bare assault, with intent to kill, is only a great misdemeanour, tho' formerly it was held to be murder.

The killing may be by poisoning, striking, starving, drowning, and a thousand other forms of death, by which human nature may be overcome. Of these the most detestable of all is poison; because it can of all others be the least prevented, either by manhood or forethought. And therefore, by the stat. 22 Hen. VIII. c. 9. it was made treason, and a more grievous and lingering kind of death was inflicted on it than the common law allowed; namely, *boiling to death*: but this act did not live long, being repealed by 1 Edw. VI. c. 12. There was also, by the ancient common law, one species of killing held to be murder, which may be dubious at this day, as there hath not been an instance wherein it has been held to be murder for many ages past, viz. bearing false witness against another, with an express premeditated design to take away his life, so as the innocent person be condemned and executed. The Gothic laws punished in this case both the judge, the witnesses, and the procurator; and, among the Romans, the *lex Cornelia de falsariis*, punished the false witness with death, as being guilty of a species of assassination. And there is no doubt but this is equally murder in *foro conscientia* as killing with a sword; though the modern law (to avoid the danger of deterring witnesses from giving evidence upon capital prosecutions, if it must be at the peril of their own lives) has not yet punished it as such. If a man, however, does such an act, of which the probable consequence may be, and eventually is, death; such killing may be murder, although no stroke be struck by himself, and no killing may be primarily intended: as was the case of the unnatural son who exposed his sick father to the air against his will, by reason whereof he died; and of the harlot, who laid her child under leaves in an orchard, where a kite struck it, and killed it. So too, if a man hath a beast that is used to do mischief; and he, knowing it, suffers it to go abroad, and it kills a man; even this is manslaughter in the owner: but if he had purposely turned it loose, though barely to frighten people, and make what is called *sport*, it is with us (as in the Jewish law) as much murder as if he had incited a bear or a dog to worry them. If a physician or surgeon gives his patient a potion or plaster to cure him, which, contrary to expectation, kills him, this is neither murder nor manslaughter, but misadventure; and he shall not be punished criminally, however liable he might formerly have been to a civil action for neglect or ignorance: but it hath been holden, that if it be not a regular physician or surgeon who administers the medicine, or performs the operation, it is manslaughter at the least. Yet Sir Matthew Hale very justly questions the law of this determination; since physic and salves were in use before licensed physicians and surgeons: wherefore he treats this doctrine as apocryphal, and fitted only to gratify and flatter licentiates and doctors in physic; though it may be of use to make people cautious and wary how they meddle too much in so dangerous an employment. In order also to make the killing murder, it is requisite that the party die within a year and a day after the stroke received, or cause of death administered; in the computation of which the whole day upon which the hurt was done shall be reckoned the first.

3. Further: The person killed must be "a reasonable

Murder.

Elect.  
Comment.

able creature in being, and under the king's peace," at the time of the killing. Therefore to kill an alien, a Jew, or an outlaw, who are all under the king's peace or protection, is as much murder as to kill the most regular-born Englishman; except he be an alien-enemy, in time of war. To kill a child in its mother's womb, is now no murder, but a great misprison: but if the child be born alive, and dieth by reason of the potion or bruises it received in the womb, it seems, by the better opinion, to be murder in such as administered or gave them. As to the murder of bastard-children, see *BASTARD*.

4. Lastly, the killing must be committed "with malice aforethought," to make it the crime of murder. This is the grand criterion which now distinguishes murder from other killing: and this malice prepense, *malitia præcogitata*, is is not fo properly spite or malevolence to the deceased in particular, as any evil design in general; the dictate of a wicked, depraved, and malignant heart; *un disposition à faire un male chose*: and it may be either *express*, or *implied*, in law. *Express* malice is when one, with a sedate deliberate mind and formed design, doth kill another: which formed design is evidenced by external circumstances discovering that inward intention; as lying in wait, antecedent menaces, former grudges, and concerted schemes to do him some bodily harm. This takes in the case of deliberate duelling, where both parties meet avowedly with an intent to murder: thinking it their duty, as gentlemen, and claiming it as their right, to wanton with their own lives and those of their fellow-creatures; without any warrant or authority from any power either divine or human, but in direct contradiction to the laws both of God and man: and therefore the law has justly fixed the crime and punishment of murder on them, and on their seconds also. Yet it requires such a degree of passive valour to combat the dread of even undeserved contempt, arising from the false notions of honour too generally received in Europe, that the strongest prohibitions and penalties of the law will never be entirely effectual to eradicate this unhappy custom, till a method be found out of compelling the original aggressor to make some other satisfaction to the affronted party, which the world shall esteem equally reputable as that which is now given at the hazard of the life and fortune, as well of the person insulted, as of him who hath given the insult. Also, if even upon a sudden provocation one beats another in a cruel and unusual manner, so that he dies, tho' he did not intend his death, yet he is guilty of murder by *express* malice; *i. e.* by an *express* evil design, the genuine sense of *malitia*. As when a park-keeper tied a boy that was stealing wood to a horse's tail, and dragged him along the park; when a master corrected his servant with an iron bar, and a schoolmaster stamped on his scholar's belly, so that each of the sufferers died; these were justly held to be murders, because the correction being excessive, and such as could not proceed but from a bad heart, it was equivalent to a deliberate act of slaughter. Neither shall he be guilty of a less crime who kills another in consequence of such a wilful act as shews him to be an enemy to all mankind in general; as going deliberately, and with an intent to do mischief, upon a horse used to strike, or coolly discharging a gun among a multitude of

people. So if a man resolves to kill the next man he meets, and does kill him, it is murder, although he knew him not; for this is universal malice. And if two or more come together to do an unlawful act against the king's peace, of which the probable consequence might be bloodshed; as to beat a man, to commit a riot, or to rob a park, and one of them kills a man; it is murder in them all, because of the unlawful act, the *malitia præcogitata*, or evil intended beforehand.

Also in many cases where no malice is expressed, the law will imply it: as, where a man wilfully poisons another, in such a deliberate act the law presumes malice, though no particular enmity can be proved. And if a man kills another suddenly, without any, or without a considerable provocation, the law implies malice; for no person, unless of an abandoned heart, would be guilty of such an act upon a slight or no apparent cause. No affront, by words, or gestures only, is a sufficient provocation, so as to excuse or extenuate such acts of violence as manifestly endanger the life of another. But if the person so provoked had unfortunately killed the other, by beating him in such a manner as shewed only an intent to chastise and not to kill him, the law fo far considers the provocation of contumelious behaviour, as to adjudge it only manslaughter, and not murder. In like manner, if one kills an officer of justice, either civil or criminal, in the execution of his duty, or any of his assistants endeavouring to conserve the peace, or any private person endeavouring to suppress an affray or apprehend a felon, knowing his authority or the intention with which he interposes, the law will imply malice, and the killer shall be guilty of murder. And if one intends to do another felony, and undesignedly kills a man, this is also murder. Thus if one shoots at A and misses him, but kills B, this is murder; because of the previous felonious intent, which the law transfers from one to the other. The same is the case, where one lays poison for A; and B, against whom the prisoner had no malicious intent, takes it, and it kills him; this is likewise murder. So also, if one gives a woman with child a medicine to procure abortion, and it operates fo violently as to kill the woman, this is murder in the person who gave it. It were endless to go through all the cases of homicide, which have been adjudged, either expressly or impliedly, malicious: these therefore may suffice as a specimen; and we may take it for a general rule, that all homicide is malicious, and of course amounts to murder, unless where justified by the command or permission of the law; excused on a principle of accident or self-preservation; or alleviated into manslaughter, by being either the involuntary consequence of some act, not strictly lawful, or (if voluntary) occasioned by some sudden and sufficiently violent provocation. And all these circumstances of justification, excuse, or alleviation, it is incumbent upon the prisoner to make out, to the satisfaction of the court and jury: the latter of whom are to decide whether the circumstances alleged are proved to have actually existed; the former, how far they extend to take away or mitigate the guilt. For all homicide is presumed to be malicious, until the contrary appeareth upon evidence.

The punishment of murder, and that of manslaughter,

slaughter, were formerly one and the same; both having the benefit of clergy: so that none but unlearned persons, who least knew the guilt of it, were put to death for this enormous crime. But now, by several statutes, the benefit of clergy is taken away from murderers through malice prepense, their abettors, procurers, and counsellors. In atrocious cases it was frequently usual for the court to direct the murderer, after execution, to be hung upon a gibbet in chains near the place where the fact was committed; but this was no part of the legal judgment; and the like is still sometimes practised in the case of notorious thieves. This, being quite contrary to the express command of the mosaical law, seems to have been borrowed from the civil law; which, besides the terror of the example, gives also another reason for this practice, viz. that it is a comfortable sight to the relations and friends of the deceased. But now, in England, it is enacted by statute 25 Geo. II. c. 37. that the judge, before whom any person is found guilty of wilful murder, shall pronounce sentence immediately after conviction, unless he sees cause to postpone it; and shall in passing sentence direct him to be executed on the next day but one (unless the same shall be Sunday, and then on the Monday following), and that his body be delivered to the surgeons to be dissected and anatomized; and that the judge may direct his body to be afterwards hung in chains, but in nowise to be buried without dissection. And, during the short but awful interval between sentence and execution, the prisoner shall be kept alone, and sustained with only bread and water. But a power is allowed to the judge, upon good and sufficient cause, to respite the execution, and relax the other restraints of this act. See further, PARRICIDE, and *PETIT Treason*.

**MURDERERS**, or *Murdering Pieces*, in a ship, are small pieces of ordnance, either of brass or iron, which have chambers put in at their breeches. They are used at the bulk-heads of the fore-castle, half-deck, or steering, in order to clear the deck, on the ship's being boarded by an enemy.

**MURENA**. See *MURÆNA*.

**MURENGERS**, two officers of great antiquity in the city of Chester, annually chosen out of the aldermen, to see that the walls are kept in repair, and to receive a certain toll and custom for the maintenance thereof.

**MURET** (Mark Anthony Francis) in Latin *Muretus*, was born at Muret, near Limoges, in 1526. He acquired a perfect knowledge of the Greek and Latin tongues without any instructor, and became one of the most learned men of his time. After having taught some time in Provence, he was made a professor at Paris in the same college with Turnebus and Buchanan. In 1554, he went into Italy; and in 1563 was professor of law, philosophy, and history, at Rome, where he died in 1585. His principal works are, 1. Excellent notes on Terence, Horace, Catullus, Tacitus, Cicero, Sallust, Aristotle, Xenophon, &c. 2. *Orationes*. 3. *Varia Lectiones, Poemata, Hymni Sacri*. 4. *Disputationes in Lib. I. Pandectorum, de Origine Juris*, &c. 5. *Epistole, Juvenilia Carmina*, &c. Most of Muret's works have been printed in the Venice edition of 1737, in 5 vols 8vo.

**MUREX**, in zoology, a genus of insects belonging to the order of vermes testacea. This animal is of the snail-kind: the shell consists of one spiral valve, rough, with membranaceous furrows; and the aperture terminates in an entire canal, either straight, or somewhat ascending. There are 60 species, particularly distinguished by peculiarities in their shells, &c.

From a species of murex was obtained the famous Tyrian dye so much valued by the ancients. This, however, has long been superseded by the use of the cochineal. One of the shells producing the dye was a kind of buccinum; but the finest, or Tyrian purple, was got from the murex. These species of shells are found in various parts of the Mediterranean. Immense heaps of them are to be seen about Tarentum to this day, evincing one place where this precious liquor was extracted. See Plate CLXXXVI fig. 1.

In the accounts of a Spanish philosopher it is mentioned, that on the coasts of Guayaquil and Guatemala in Peru the murex is also found. The shell which contains it adheres to the rocks that are washed by the sea: it is of the size of a large walnut. The liquor may be extracted two ways; some kill the animal after they have drawn it out of the shell; then press it with a knife from head to tail; separate from the body the part where the liquor is collected, and throw away the rest. When this operation, after being repeated on several snails, has afforded a certain quantity of fluid, the thread intended to be dyed is dipped in it, and the process is finished. The colour, which is at first of the whiteness of milk, becomes afterwards green, and is not purple till the thread is dry. Those who disapprove of this method, draw the silk partly out of the shell, and, squeezing it, make it yield a fluid which serves for dyeing; they repeat this operation four times at different intervals, but always with less success. If they continue it, the fish dies. No colour at present known, says the abbé Raynal, can be compared to this, either as to lustre, liveliness, or duration. It succeeds better on cotton than wool, linen, or silk.

**MURIA**, *Alimentary salt*. See *SALT*.

**MURRAIN**, or *GARGLE*, a contagious disease among cattle. The symptoms are, a hanging down and swelling of the head, abundance of gum in the eyes, rattling in the throat, a short breath, palpitation at the heart, staggering, a hot breath, and a shining tongue. In order to prevent this disease, the cattle should stand cool in summer, and have plenty of good water: all carrion should be speedily buried; and as the feeding of cattle in wet places, on rotten grass and hay, often occasions this disease, dry and sweet fodder should be given them.

**MURRAY**, a county of Scotland, extending by the coast from the river Spey on the east to Beaulen on the west, which is the boundary of the province of Ross; and comprehending the countries of Stath-spey, Badenoch, Strathern, Strathnairn, and Stratherrick.

According to the account of the reverend Mr Shaw minister of Elgin, in answer to some queries of Mr Pennant, the country produces wheat, barley, oats, rye, pease, and beans. Of these, in plentiful years, upwards of 20,000 bolls are exported, besides serving the

Murray. the country itself and some of the Highland countries. Some hemp is also cultivated, and a great deal of flax; of which linen is made, not only for home-consumption, but a considerable quantity of linen-yarn is exported. Great quantities of potatoes are also cultivated. Several hundreds of black cattle also are exported from the Highlands of Murray, but few or none from the Lowlands.—Peculiar to this province is a kind of wood, called *red saugh*, or *fallow*; which is no less beautiful than mahogany. It is much more firm and tough than mahogany, and resembles the lighter-coloured kind of that wood. It receives a fine polish, but is very scarce, growing on rocks. But there are great forests of firs and birches, which our author thinks are the remains of the Sylva Caledonia. Here also is found a remarkable root, called by the natives *carmele*: it grows in heaths and birch-woods to the bigness of a large nut; and sometimes there are four or five roots joined together by fibres. It has a green stalk, and small red flowers. Dio, speaking of the Caledonians, says, *Certum cibi genus parant ad omnia, quem si ceperint quantum est unius saba magnitudo, minime esurire aut sitire solent*. Cæsar also tells us of a root called *chara*, which his soldiers mixed with milk and made into bread when in want of provision, which greatly relieved them. This root, Mr Shaw thinks, is the same with the *carmele*, or *sweet root* of Murray. He informs us, that he hath often seen it dried, and kept for journeys through hills where no provision was to be had: he has likewise seen it pounded and infused; the liquor makes a more agreeable and wholesome liquor than mead. It grows in such plenty, that a cart-load of it can easily be gathered.

Murray is intersected by the rivers Spey, Lossie, Findern, Nairn, Nefs, and Beaulie. The river of Spey, rising on the borders of Lochaber, is more than 60 Scots, or 100 English miles long, but too rapid to be navigable. Upon this river great floats of fir and birch-wood are carried down to the Frith; the float is guided by a man sitting on a *courach*. This vessel is of an oval shape, about four feet long and three broad; a small keel from head to stern; a few ribs cross the keel, and a ring of pliable wood round the lip of it; the whole covered with the rough hide of an ox or horse. The rower sits on a transverse seat in the middle, and holds in his hand a rope, the end of which is tied to the float, and with the other hand he manages a paddle, keeps the float in deep water, and brings it to shore when he pleases. In this province, also, is Loch Nefs, remarkable for its never freezing. There are many other lakes in this country, of which one called *Dundelback* is remarkable in that it is never covered with ice before the month of January; but after that time one night's strong frost covers it all over. On the east side of Loch Nefs, a large mile above the loch, is the waterfall of Foher, where the river *Feash-Len* falls over a steep rock about 80 feet high; and a thick fog rises from the place where it falls, occasioned by the violent dashing of the water. There is a considerable salmon-fishery on the rivers Spey, Findern, Nefs, and Beaulie, which serves the towns and country, besides exporting to the value of 12,000 l. annually.

There are many natural caves in the hills of this country, which formerly were the receptacles of thieves and robbers, and now afford shelter to hunters and shepherds in stormy weather. The most remarkable mountain is *Carnegern*, in Strathpey. In it are found a particular kind of stones well known to the lapidaries. They are of blue, green, yellow, and amber colours; some so large as to make snuff-boxes, or small cups; some of hexagonal or pentagonal figures, and tapering to a point at each end. The mountain of Benalar, in Badenoch, is by Mr Shaw reckoned to be the highest land in Scotland, as waters flowing from it fall into the sea at Dundee, Inverlochry, and Garmoch in Murray.

MUS, in zoology, a genus of quadrupeds, belonging to the order of gliræ; the genuine character of which is, that the fore-teeth of the lower jaws are subulated. There are species.

1. The porcellus, or Guinea-pig, so called from its being supposed to come only from Guinea, is a native of Brazil as well as Guinea. It is about the size of a young pig, and hath erect hair not unlike it. The colour is white or white varied with orange and black in irregular blotches; hath no tail, but very large broad ears rounded at the sides. These animals are of such a hot constitution, that they copulate five or six weeks after birth. They acquire not, however, their full growth before the eighth or ninth month. But this increase of size consists only of fat; for the solid parts are fully unfolded before the age of six months. The females go with young only three weeks: the first litter consists of four or five; the second of five or six; and the succeeding ones of seven or eight, and sometimes of 10 or 12. The mother suckles her young 12 or 15 days: she banishes them as soon as she receives the male, which happens at farthest three weeks after her delivery; and if any of them persist in following her, they are maltreated and killed by the male. As they breed so fast, their multitudes would be innumerable, if there were not so many enemies which destroy them. They cannot resist either cold or moisture; when cold, they assemble and crowd close together, in which case they often all perish together. They are also devoured in great numbers by cats, and many are killed by the males. Though perpetually throwing out urine, they never drink. They feed on all kinds of herbs; but especially on parsley, which they prefer to grain or bread; and they are likewise fond of apples and other fruits. They eat precipitately like the rabbit, little at a time, but very often; make a grunting noise like a little pig, and are very restless. No mention is made by natural historians of the manners of this animal in a wild state. Their skin is hardly of any value; and their flesh, though eatable, is not so good as to be much demanded: but it might be improved by keeping them in warrens, where they would have the benefit of the fresh air, and the liberty of choosin' herbs agreeable to their taste. Those kept in houses have nearly the same bad taste with warren-rabbits; and those kept in gardens during the summer, have an insipid, but less disagreeable flavour.

2. The aguti, is about the size of a hare, has a short tail; four toes on the fore-feet, three on the hind ones; and a yellowish belly. According to M. Buffon, it is an animal peculiar to the southern parts of America, being

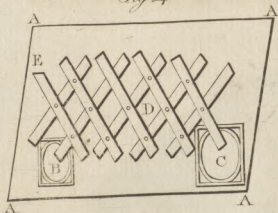
*Fig. 1.* MUS PORCELLUS or  
Guiney Pig



*Fig. 2.* MUS AGUTI



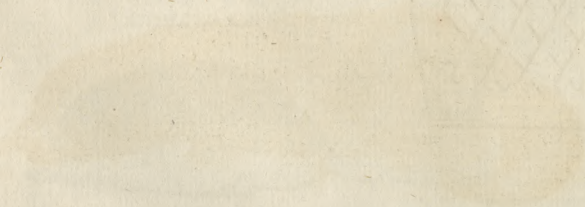
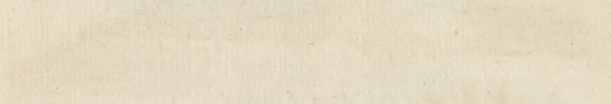
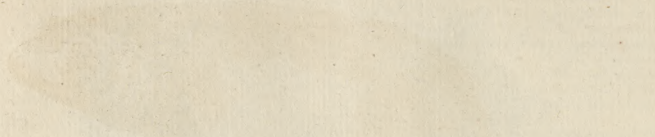
*Fig. 4*



*Fig. 3.*  
MUS AVELLONARIUS



1725.10.11



1725.10.11

*Fig. 1. MUS MARMOTTA  
or Alpine mouse.*



*Fig. 2.  
MUS JACULUS.*



*Fig. 3.  
MUS LEMMUS.*

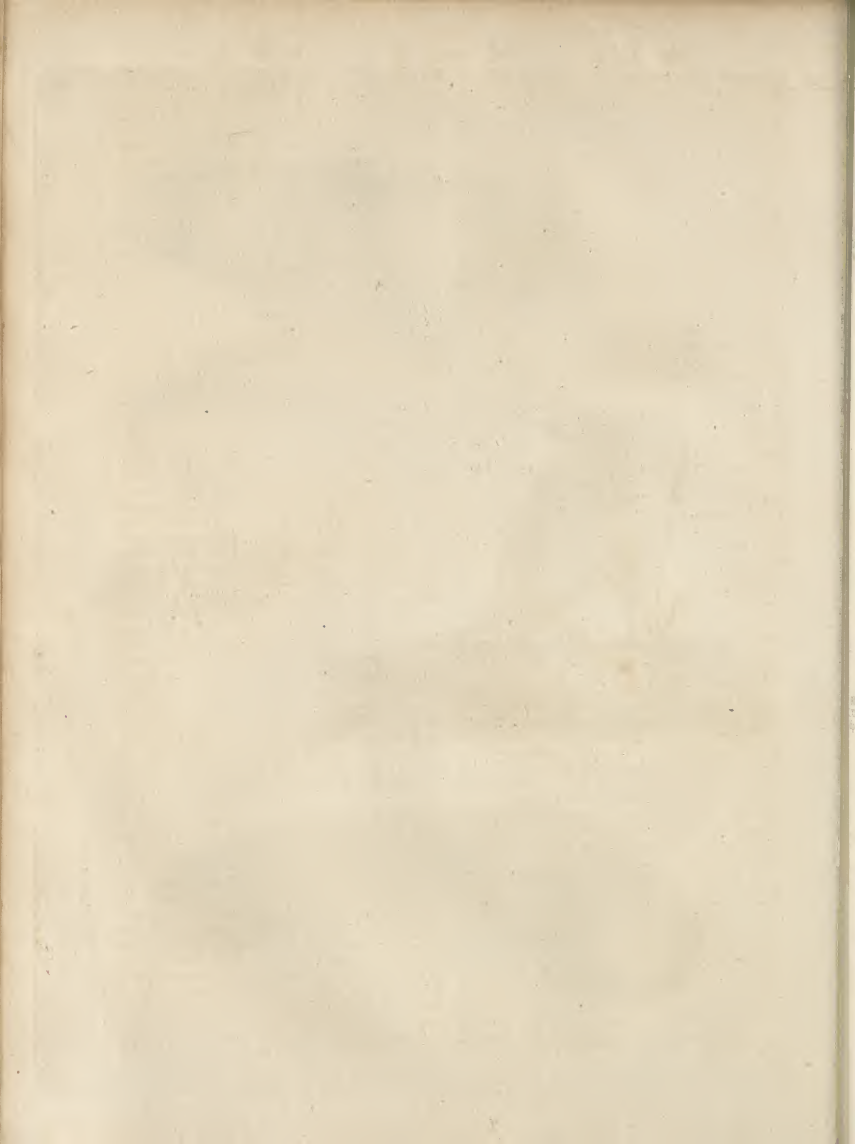


*Fig. 4. MUS TELA LUTRA or Otter.*



*Fig. 5. MUS-INGUINA See Next Plate.*

*A. Bell Sculp<sup>t</sup>*





Mus. ing never found in the old world. It is common in Brazil, Guiana, St Domingo, and all the islands; and seems to require a warm climate in order to subsist and multiply. However, they can live in France, if kept in a dry place, and sheltered from winter-frosts. The aguti is a very mischievous animal, and bites cruelly: he grunts like a pig; is very voracious; fits on his hind-legs, and holds his food with the fore-feet when he eats: hides what he cannot consume: hops like a hare, and runs very fast both on plain and rising grounds; but as his fore-legs are much shorter than the hind-ones, he would tumble headlong if he did not slacken his course in descending. Both his eye and his ear are fine; he flops and listens to the sound of music: the flesh of those which are fat and well-fed is not very bad, though it be hard, and not very agreeable to the taste. They scald the aguti, and make him ready in the same manner as a pig. He is hunted with dogs. When forced among the cut sugar-canes, he is soon taken; because these grounds being generally covered a foot thick with straw and leaves, at each leap he sinks in this litter, so that a man may overtake and slay him with a baton. He commonly runs very nimbly before the dogs; and when he gains his retreat, he lies squat, and remains obstinately in his concealment. The hunters are obliged to chase him out by filling his hole with smoke. The animal, half suffocated, utters mournful cries; but never issues forth, unless when pushed to the last extremity. His cry, which he often repeats when disturbed or irritated, resembles that of a small hog. If taken young, he is easily tamed, and goes out and returns of his own accord. These animals commonly reside in the woods and hedges; where the females choose a place well covered and bushy, and there prepare a bed of leaves and hay for their young. They annually produce two or three, but generally two. Like the cats, they transport their young, two or three days after birth, into the hollows of trees, where they suckle them for a short time; the young are soon in a condition to follow their mother, and to search for food.

Plate CLXXXIII  
fig. 2.  
3. The leporinus, or Java hare, is about the size of an ordinary hare: the hair of a reddish brown-colour; the head small in proportion to the body; the eyes large and prominent; the ears like those of a rat; in other respects the head resembles both a deer and hare; the hind-part of the body and thighs remarkably big; the legs long; four toes on the fore-feet, and three on the hind-feet: is a native of Java and Sumatra. The above description was taken from an animal of this kind in the possession of the duke of Richmond. It was very tame and inoffensive, and fed only on fruit and other vegetables.

4. The citellus, or carlefs marmot, hath a short tail, an ash-coloured body, and no ears. It inhabits Bohemia, Austria, Hungary, and Siberia. It hath been confounded with the cricetus, or hamster; but, according to M. Buffon, the differences between them are very conspicuous, chiefly in the want of ears in the citellus; for though the ears of the hamster are short, they are broad, and very observable; the citellus also never copulates with the hamster, which is sufficient to remove every doubt with regard to the diversity of their species. This creature burrows, and forms its magazine of corn, nuts, &c. for its winter-food. It

fits up like a squirrel. By Gmelin's account, some inhabit the fields in Siberia, others penetrate into granaries; the former make holes in the ground with a double entrance, and sleep during winter in the centre of their lodge: those which inhabit the granaries are in motion during the whole of the cold season. They couple in the beginning of May, and bring from five to eight young, which they bring up in their burrows, and cover with hay. They whittle like the marmot; are very irascible, and bite very feverly: their furs were once used by the ladies of Bohemia to make cloaks.

5. The lemmus, or lemming, hath a short tail, five toes on both fore and hind feet, and the body is variegated with green and yellow. This creature, which is one of the most singular that we know of, is said to be a native of the mountains of Kolin in Lapland. They appear not every year; but at certain unforeseen periods they come in such numbers, that they spread every where, and cover the whole surface of the earth. The arrival of the lemmings is considered as a terrible scourge, the effects of which it is impossible to avoid. They make dreadful devastations in the fields; lay waste the gardens; ruin the crops; and leave nothing, except what is shut up in houses, where they never enter. They bark nearly like small dogs. When attacked, they neither fear clubs nor halberds, but dart against those who strike them, outrageously biting, and fixing upon the weapons employed to kill them. When struck at with a stick, they seize it so forcibly with their teeth, that they allow themselves to be carried to a considerable distance without quitting their hold. They dig holes in the earth, and make roads like the moles, in quest of roots. They sometimes make war, and divide themselves into two armies along the lakes and meadows. Their enemies are foxes and ermines, who devour great numbers of them. Grats that has been ate down, and springs again, is said to kill them: and they seem likewise to commit suicide; for they are often found suspended on the branches of trees; and they probably throw themselves in troops into the waters like the swallows. It would also appear, that the lemmings, like the rats, mutually destroy and eat each other, when pasture fails them; and that this is the reason why their destruction is as sudden as their multiplication. At particular times they assemble together, and the whole die in company. They are very courageous, and defend themselves against other animals. It is not certainly known whence they come. The vulgar believe that they fall from the clouds along with the rain. Upon the renewal of the grats they infallibly die. In fine weather they take to the water in vast multitudes; but when a breeze of wind arises, they are all drowned. The number of these animals is so prodigious, that when they die the air is infected, and produces many diseases. They even seem to infect the plants which they gnaw; for the pasture then kills the cattle. The flesh of the lemmings is not good to eat; and their skin, though the hair be fine, does not answer for making furs, because it is too thick.

6. The paca, or spotted cavy, is an animal peculiar to the new world, particularly Brazil. It has a short tail, five toes on each foot, and three yellowish lines on each side. It resembles a pig of two months old; and its flesh is fat, and makes excellent food.

Mus.

Plate  
CLXXXIV  
fig. 3.

Even the skin is eat, like that of a pig. For these reasons this animal is in perpetual quest. It is difficult for the hunters to take him alive. When surprised in his hole, which they lay open both before and behind, he defends himself, and even bites fiercely. His skin, though covered with coarse short hair, makes a very good fur, because it is regularly spotted on both sides. These animals produce often and in great numbers; many of them are destroyed by men and beasts of prey, and yet the species is always numerous.

When kept in a wooden cage or box, this animal remains perfectly tranquil during the day, especially when plentifully supplied with food. He seems even to have an affection for his retreat as long as the day lasts; for, after feeding, he retires spontaneously into it. But when night approaches, by perpetual restlessness and agitation, and by tearing the bars of his prison with his teeth, he discovers a violent desire of getting out. Nothing of this kind happens during the day, unless he has occasion for some natural evacuation; for he cannot endure the smallest degree of dirtiness in his little apartment; and when about to void his excrements, always retires to the most distant corner he can find. When his straw begins to smell, he often throws it out, as if he meant to demand fresh litter. This old straw he pushes out with his muzzle, and goes in quest of rags or paper to replace it. In a female cavity, the following extraordinary instance of cleanliness was observed. A large male rabbit being shut up with her when she was in season, she took an aversion to him the moment he voided his excrement in their common apartment. Before this she was very fond of him; licked his nose, ears, and body; and allowed him to take almost the whole food that was given her. But as soon as the rabbit had infected the cage with his ordure, she retired into the bottom of an old press, where she made a bed with paper and rags, and returned not to her old lodging, till she saw it neat, and freed from the unclean guest which had been presented to her.

The spotted cavity is easily accustomed to a domestic life. Unless indelicately irritated, he is gentle and tractable. He is fond of adulation, and licks the hands of the person who caresses him. He knows those who take care of him, and readily distinguishes their voices. When gently stroked on the back, he stretches himself out, lies down on his belly, by a small cry expresses his acknowledgment, and seems to ask a continuance of the favour. When seized in a rough manner, however, he makes very violent efforts to escape.

7. The marmot, or marmot, has a short hairy tail, round ears, and gibbous cheeks. It is found only on the tops of the highest mountains, and is more subject to be rendered torpid by cold than any other. In the end of September, or beginning of October, he retires into his hole, from which he comes not out till the beginning of April. His retreat is capacious, broader than long, and very deep, so that it can contain several marmots, without any danger of corrupting the air. With their feet and claws, which are admirably adapted for the purpose, they dig the earth with surprising quickness, and throw it behind them. It is not a hole, or a shaft or winding tube, but a species of gallery made in the form of a Y, each branch of which has an aperture, and both terminate in one where the animal

lodes. As the whole is made on the declivity of a mountain, the innermost part alone is on a level. Both branches of the Y are inclined, and the one is used for depositing the excrements of the animals, and the other for their going out and coming in. The place of their abode is well lined with moss and hay, of which they make ample provision during the summer. It is even affirmed, that this labour is carried on jointly; that some cut the finest herbage, which is collected by others, and that they alternately serve as vehicles for transporting it to their dens. One, it is said, lies down on his back, allows himself to be loaded with hay, extends his limbs, and others trail him in this manner by the tail, taking care not to overfat him. These repeated frictions are assigned as the reason why the hair is generally rubbed off their backs. But it is more probable, that this effect is produced by their frequent digging of the earth. But, whatever may be in this, it is certain that they dwell together, and work in common at their habitations, where they pass three-fourths of their lives. Thither they retire during rain, or upon the approach of danger; and never go out but in fine weather, and even then to no great distance. One stands sentinel upon a rock, while the others sport on the grass, or are employed in cutting it to make hay. When the sentinel perceives a man, an eagle, a dog, &c. he alarms the rest with a loud whistle, and is himself the last to enter the hole. They make no provisions for winter; nor have they in that season any occasion for them, as lying asleep all that time. As soon as they perceive the first approaches of the sleeping season, they set to work in shutting up the two entrances of their habitation; and this they perform with such labour and solidity, that it is easier to dig the earth any where else than in the parts they have fortified. They are at this time very fat, weighing sometimes 20 pounds; and they continue to be plump for three months; but afterwards they gradually decay, and are extremely emaciated at the end of winter. When discovered in their retreats, they are found rolled up in the form of a ball, covered with hay; and they are carried off in so torpid a state, that they may be killed without seeming to feel pain. The fattest are chosen for eating, and the young ones for taming. When taken young, they may be rendered nearly as tame as our other domestic animals. They learn to seize a stick, to dance, to perform various gesticulations, and to obey the voice of their master. Like the cat, the marmot has an antipathy against dogs. When he begins to be familiar in the house, and perceives that he is protected by his master, he attacks and bites dogs of the most formidable kind. Though not so large as a hare, he is flouter, and his strength is aided by a peculiar suppleness and dexterity. With his fore-teeth, which are pretty long, he bites most cruelly; he attacks not, however, either dogs or men, unless previously irritated. If not prevented, he gnaws furniture and stuffs; and when confined, pierces even through wood. His voice resembles the murmuring of a young dog when caressed or in a sporting humour; but, when irritated or frightened, he makes a whistling noise, so loud and piercing, that it hurts the ear. The marmots eat every thing presented to them; as flesh, bread, fruit, roots, pot-herbs, may-bugs, grasshoppers, &c. but milk and butter they prefer to

Mus.

every other aliment. Though less inclined to theft than the cat, they endeavour to slip into the dairy, where they drink great quantities of milk, making, like the cat, a murmuring noise expressive of pleasure. Milk is also the only liquor that is agreeable to them; for they rarely drink water; and they refuse wine. They produce but once a year, and the litter generally consists of three or four. The growth of their young is very quick; they live only nine or ten years; and the species is neither numerous nor much diffused. The marmot would make very good eating, if it had not always a disagreeable flavour, which cannot be concealed but by strong seasonings.

8. The monax, or marmot of Canada, has a hairy tail, an ash-coloured body, roundish ears, and four toes on the fore-feet, and five on the hind-ones. It is a native of America, and differs very little from the former.

9. The circetus, hamster, or German marmot, is the most famous as well as the most destructive of all the rats. It has a tail of a moderate length, round ears, a black belly, and reddish sides, with three white spots. This creature sleeps during the winter like the marmots; when in a torpid state, neither respiration, nor any kind of feeling, can be perceived. The heart, however, beats 15 times in a minute, which has been discovered by opening the chest. The blood continues to be fluid, but the intestines are not irritable; even an electrical shock does not awake him; but in the open air he never becomes torpid. When dug up in his state of torpidity, the hamster is found with his head bent under his belly between the two fore-legs, and those behind rest upon his muzzle. The eyes are shut; and when the eye-lids are forced open, they instantly close again. The members are stiff, like those of a dead animal, and the whole body feels as cold as ice. When dissected during this state, he seems to feel very little; sometimes indeed he opens his mouth as if he wanted to respire; but his lethargy is too strong to admit of his awakening entirely. This lethargy hath been ascribed solely to a certain degree of cold; which indeed may be true with regard to dormice, bats, &c. But experience shews, that, in order to render the hamster torpid, he must also be excluded from all communication with the external air: for when he is shut up in a cage filled with earth and straw, and exposed in winter to a degree of cold sufficient to freeze the water, he never becomes torpid: but when the cage is sunk four or five feet under ground, and well secured against the access of the air, at the end of eight or ten days he is equally torpid as if he had been in his own burrow. If the cage is brought up to the surface, the hamster will awake in a few hours, and resume his torpid state when put below the earth. The experiment may be repeated with the same success as long as the frost continues. We have a farther proof that the absence of the air is one of the causes of torpidity in the hamster; for when brought up from his hole in the coldest weather, and exposed to the air, he infallibly awakes in a few hours. This experiment succeeds as well in the night as in the day; which shews that light has no share in producing the effect. It is curious to observe the hamster passing from a torpid to an active state. He first loses the rigidity of his members, and then makes a profound respira-

tion, but at long intervals. His legs begin to move, he opens his mouth, and utters disagreeable and rattling sounds. After continuing these operations for some time, he opens his eyes, and endeavours to raise himself on his legs. But all these movements are still reeling and unsteady, like those of a man intoxicated with liquor. He, however, reiterates his efforts till he is enabled to stand on his legs. In this attitude he remains fixed, as if he meant to reconnoitre and repose himself after his fatigue; but he gradually begins to walk, cat, and act in his usual manner. This passage from a torpid to an active state, requires more or less time, according to the temperature of the air. When exposed to a cold air, he sometimes requires more than two hours to awake; and in a more temperate air he accomplishes his purpose in less than an hour. It is probable that, when the hamster is in his hole, this change is performed imperceptibly, and that he feels none of the inconveniences which arise from a sudden and forced revivification.

The hamster is a very mischievous animal; and so exceedingly fierce, that he seems to have no other passion but rage. In consequence of this, he attacks every other animal that comes in his way, without regarding the superior size or strength of his antagonist; nay, as if he was ignorant of the method of saving himself by flight, he allows himself to be beat to pieces with a stick, rather than yield. If he seizes a man's hand, he must be killed before he quits his hold. When the hamster perceives a dog at a distance, he begins with emptying his cheek-pouches if they happen to be filled with grain, and which are so capacious as to hold a quarter of a pint English. He then blows them up so prodigiously, that the size of the head and neck greatly exceeds that of the body. Lastly, he raises himself on his hind-legs, and in this attitude darts on his enemy. If he catches hold, he never quits it but with the loss of life. But the dog generally seizes him behind, and strangles him. This ferocious temper prevents the hamster from being at peace with any other animal. He even makes war against his own species, not excepting the females. When two hamsters encounter, they never fail to attack each other, and the stronger always devours the weaker. A combat between a male and a female lasts longer than between two males. They begin by pursuing and biting each other; then each of them retires to a side as if to take breath; a little after, they renew the combat, and continue to fly and to fight till one of them falls. The vanquished uniformly serves for a repast to the conqueror.

The hamsters copulate about the end of April; when the males enter the apartments of the females, where they remain only a few days. If two males happen to meet in the same hole, a furious combat ensues, which generally terminates in the death of the weakest. The conqueror takes possession of the female, and both, though at every other period they persecute and kill each other, lay aside their rural ferocity during the few days their amours continue. They even mutually defend each other against aggressors; and if a hole is opened about this time, the female defends her husband with the utmost fury. The females bring forth twice or thrice every year. Their litter is never fewer than six, and more frequently than

Mus.

Mus.

from 16 to 18. Their growth is very rapid. At the age of 15 days they begin to dig the earth; and soon after, the mother banishes them from her habitation; so that at the age of about three weeks they are abandoned to their own management. The mother in general discovers little affection for her offspring; and when her hole is opened, flies in the most dastardly manner, leaving her young ones to perish. Her only sollicitude at that time is to provide for her own defence. With this view she digs deeper into the earth, which she performs with amazing quickness. The young would willingly follow her; but she is deaf to their cries, and even shuts the hole which she had made.

As the hamster lives on grains, and dwells under the earth, some kinds of soils are inconvenient for him. He requires a soil which is easily pierced, and yet so tenacious as not to tumble down. Stony, sandy, and argillaceous soils, are therefore improper, as well as meadows, forests, and marshy grounds. He likewise chooses countries which abound in all kinds of grain, that he may not be obliged to seek his food at great distances. In Thuringia, the soil of which possesses all these qualities, the hamsters are more numerous than in any other country. The habitations are dug to the depth of three or four feet, and consist of more or fewer apartments, according to the age of the animal. The principal apartment is lined with straw, and serves him for a lodging. The others are destined for the preservation of provisions, of which he amasses great quantities during the autumn. Each hole has two apertures: the one descends obliquely; and the other, through which the animal goes out and in, is perpendicular. The holes of the females, who never live with the males, are somewhat different. In those where she brings forth, there is seldom above one chamber for provisions; because the short time the young remain with her requires not a great store of food. But instead of one perpendicular hole, she makes seven or eight, to give free passage to her young. Sometimes the mother banishes her offspring, and continues to possess this hole; but the commonly digs another, and lays up as much provisions as the season permits her to collect.

The hamster feeds upon all kinds of herbs, roots, and grains, which the different seasons produce. He even eats the flesh of such animals as he can conquer. As he is not adapted for long journeys, his magazine is first stocked with the provisions which are nearest his abode. This is the reason why some of his chambers are frequently filled with one kind of grain only. When the harvest is reaped, he goes to a greater distance in quest of provisions, and carries every article he can find, without distinction, to his granary. To facilitate the transportation of his food, nature has furnished him with two pouches in the inside of each cheek. On the outside, these pouches are membranous, smooth, and shining; and in the inside there are a great many glands, which secrete a certain fluid, to preserve the flexibility of the parts, and to enable them to resist accidents which may be occasioned by the roughness or sharpness of particular grains. Each of these receptacles is capable of containing an ounce and an half of grain, which, on his return to his lodging, he empties, by pressing his two fore-feet against his cheeks.

Mus.

When we meet a hamster having his cheeks filled with provisions, it is easy to seize him with the hand, without the risk of being bitten; because in this condition he has not the free motion of his jaws. But if he is allowed a little time, he soon empties his pouches, and stands upon his defence. The quantity of provisions found in the holes depends on the age and sex of the inhabitant. The old hamsters frequently amass 100 pounds of grain; but the young, and the females, content themselves with a quantity much smaller. Their object in laying up provisions, is not to nourish them during winter, which they pass in sleep, and without eating; but to support them after they awake in the spring, and previous to their falling into a torpid state, which resembles a profound sleep. At the approach of winter, the hamsters retire into their subterraneous abodes, the entrance to which they shut up with great address. Here the animal reposes, in the situation already described, upon a bed of straw; and in this state he is commonly dug up. In winter the peasants generally go a *hamster-messing* as they call it; the retreat is known by a small eminence of earth raised near the oblique passage formerly described. The peasants dig down till they discover the hoard, and are generally well paid for their trouble; as they often find two bushels of corn, besides the skins of the animals, which are valuable furs; and it is remarkable that the hair sticks so fast to the skin, that it cannot be plucked off without the utmost difficulty. In some seasons the hamsters are so numerous, that they occasion a dearth of corn. Pole-cats are their greatest enemies; for they pursue them into their holes, and destroy great numbers.

10. The terrestrial, or short-tailed field-mouse, has a hairy tail, with four toes on the fore-feet, and five on the hind-ones, and ears shorter than the hair. It inhabits Europe, and is found in great numbers in Newfoundland. It digs holes in the earth, where it amasses grain, filberts, and acorns; but it appears to prefer corn to every other food. When the grain is ripe, the short-tailed field-mice assemble from all quarters, and often do great damage by cutting the stalks of corn, in order to come at the ears. They follow the reapers, and eat up all the fallen and neglected grain. When the gleanings are devoured, they flock to the new-sown fields, and destroy the crop of the ensuing year. In winter most of them retire into the woods, where they feed upon filberts, acorns, and the seeds of trees. In particular years they appear in numbers so immense, that they would destroy every thing if they continued long; but they always kill and eat one another during a scarcity of provisions. They besides are devoured by the long-tailed field-mice, by foxes, wild-cats, and weasels. These creatures are often carried home in the sheaves of corn; and 100 of them have been found in housing a rick. In such cases it hath been observed, that the dogs devoured all the mice of this sort they could find, rejecting the common kind; and, on the contrary, the cats would touch none but the last. This animal makes its nest in moist meadows, and brings eight young at a time: it has a strong affection for them; one that was seduced into a wire-trap by placing its brood in it, was so intent on fostering them, that it appeared quite regardless of its captivity. In Newfoundland, these mice

mice are very destructive to gardens; but seldom do much damage in this way in Britain.

11. The amphibius, or water-rat, has a long hairy tail, but not palmated feet, as is said by Linnæus. It is about the size of a rat, but in its manners resembles the otter much more than the rat. Like the otter, it frequents the fresh water, and is found on the banks of rivers, brooks, and pools. Gudgeons, minnows, blays, and the fry of carps, pikes, and barbels, are its ordinary food. It likewise eats frogs, water-insects, and sometimes the roots of plants. He swims with great ease, keeps long under water, and carries off his prey to be devoured on the grafs or in his hole. He is sometimes surpris'd by the fishermen when searching for craw-fish; and he endeavours to escape by biting their fingers, or leaping into the water. Like the otter, he avoids large rivers, or rather those which are much frequented. He never visits houses or barns; but keeps upon the margins of waters, from which he wanders not upon dry land so far as the otter, who is sometimes found at the distance of a league from water. Water-rats are seldom met with in elevated places or dry plains, but are extremely numerous in moist and marshy valleys. The females come in season about the end of winter, and bring forth in the month of April, the litter generally consisting of six or seven. Perhaps they bring forth more than once a-year; but of this we have no proper knowledge. This animal, as well as the otter, is eaten by the French peasants on *maigre-days*. Water-rats are found all over Europe, excepting in the polar regions. According to Bellon, they inhabit the banks of the Nile; but the figure he gives of them has so little resemblance to our water-rat, that it is probable the Nile-rats belong to another species of animals.

12. The rattus, or common rat, is the most pernicious of any of our smaller quadrupeds. Meat, corn, paper, cloaths, furniture, in short every conveniency of life, is a prey to this destructive creature. Nor are its devastations confined to these; for it will make equal havoc among poultry, rabbits, or young game; nay, it hath been known to gnaw the extremities of infants when asleep. It is a domestic animal, residing very frequently in houses, barns, or granaries; and it is furnished with fore-teeth of such strength as enable it to force its way through the hardest wood or the oldest mortar. Several small animals have been confounded under the general name of *rat*; but the appellation seems properly to belong only to two; namely, the common black, and the brown rats. The black rats are not of a perfectly black colour, but of a deep iron grey, with an ash-coloured belly, the legs dusky, and almost naked; they have a claw, in the place of a fifth toe, on the fore-feet; the length from the nose to the tail seven inches, the tail nearly eight. It inhabits most parts of Europe, but of late the numbers have been very much lessened by the other kind. It makes a lodge either for its day's residence, or a nest for its young, near a chimney; and improves the warmth of it, by forming there a magazine of wool, bits of cloth, hay, or straw. It lodges also in cieling, and in the void spaces between the wall and the wainscoting. From these lurking places the rats issue in quest of food, and transport thither every substance they can drag, forming considerable magazines, espe-

cially when they have young to provide for. The female brings forth several times in a year, but always in the summer-season. The litter generally consists of five or six; and in spite of poison, traps, and cats, they thus multiply to such a degree as sometimes to do a great deal of damage. In old country-houses where grain is kept, and where the vicinity of barns and magazines facilitates their retreats, they often increase so prodigiously, that the possessors are obliged to remove and desert their habitations, unless the rats happen to destroy each other. This, however, frequently happens; for these creatures, when pinched for food, devour each other. When a famine happens by reason of too many being crowded into one place, the strong kill the weak, open their heads, and first eat the brain, and then the rest of the body. Next day the war is renewed, and continues in the same manner till most of them are destroyed; which is the reason why these animals, after being extremely troublesome for some time, disappear all of a sudden, and do not return for a long time.

Rats are extremely lascivious; they squeak during their amours, and cry when they fight. They soon learn their young to eat; and when they begin to issue from the hole, their mother watches, defends, and even fights with the cats, in order to save them. A large rat is more mischievous than a young cat, and nearly as strong; the rat uses her fore-teeth, and the cat makes most use of her claws; so that the requires both to be vigorous, and accustomed to fight, in order to destroy her adversary. The weasel, tho' smaller, is a much more dangerous and formidable enemy to the rat, because he can follow it into its retreat. Their strength being nearly equal, the combat often continues for a long time, but the method of using their arms is very different. The rat wounds only by reiterated strokes with his fore-teeth, which are better formed for gnawing than biting; and being situated at the extremity of the lever or jaw, they have not much force. But the weasel bites cruelly with the whole jaw, and instead of letting go its hold, sucks the blood from the wounded part, so that the rat is always killed. The rat was first introduced into America by the Europeans in 1544, and is now the pest of all that continent.

The brown or Norway rat is much larger than the black kind; being nine inches from the end of the nose to the beginning of the tail; the length of the tail itself is the same, the usual weight 11 ounces. Notwithstanding its name, however, it is not known in Norway, nor in any part of Scandinavia. It was never known in Britain till about 45 years ago; and made its appearance in the neighbourhood of Paris only about 22 years ago. Mr Pennant suspects, that this rat came originally in ships from the East Indies; a large brown species being found there, called *bandidotes* by the natives, which burrow under ground. Barbot also mentions a species inhabiting the fields in Guinea, and probably the same with this. Wherever this creature has taken up its residence, it hath totally extirpated the black kind; however, it is to be feared we shall reap little benefit by the exchange; for the Norway rat hath the same disposition, with greater abilities for doing mischief than the common kind. It burrows, like the water-rat, in the banks of rivers, ponds,

ponds, and ditches; it takes the water very readily, and swims and dives with great celerity: like the black species, it preys on rabbits, poultry, and all kinds of game. It increases most amazingly fast, producing from 14 to 18 young at a time. Its bite is not only feverish but dangerous; the wound being immediately attended with great swelling, and is a long time in healing. These creatures are so bold as to turn upon those who pursue them, and fasten on the stick or hand of such as offer to strike them.

13. The musculus, or common mouse, has a long naked tail, four toes on the fore-feet, and five on the hind-feet, but no claw on the large toe. It has the same instinct, and the same constitution and natural dispositions with the rat, differing only in the mere circumstances of size and strength. The mouse never issues from his hole but in quest of food, and runs in again upon the least alarm. He goes not, like the rat, from house to house, unless he be forced, and is not near so destructive. He is also capable of being tamed to a certain degree, though not so perfectly as other animals. He hath many enemies, from whom he can escape only by his agility and minuteness. Owls, birds of prey, cats, weasels, and even rats, make war upon the mice, so that they are destroyed by millions; yet the species still subsists by its amazing fecundity. They bring forth at all seasons, and several times in the year: the litter generally consists of five or six; and in less than 15 days the young disperse, and are able to provide for themselves. Aristotle tells us, that having shut up a pregnant mouse in a vessel, along with plenty of grain, he found in a short time after 120 mice, all sprung from the same mother. All mice are whitish under the belly, and some are altogether white. Others are more or less brown and black. They are generally diffused over Europe, Asia, and Africa; but it is alleged that they were introduced into America by the Europeans. It is certain, however, that this little animal follows man, and flies from uninhabited places; probably on account of its natural appetite for bread, cheese, butter, &c. which men prepare for themselves.

14. The avellanarius, or dormouse, is equal in size to the former, but of a plumper appearance; the nose is more blunt; the head, sides, belly and tail, are of a tawny red colour, the throat white. Dormice inhabit woods, or very thick hedges; forming their nests in the hollow of some low tree, or near the bottom of a clove shrub: they form little magazines of nuts, and eat in an upright posture like the squirrel. The consumption of their hoard, however, during the rigour of the season, is but small; for they sleep most of the time, retiring into their holes; at the approach of winter, they roll themselves up, and become torpid. Sometimes they experience a short revival in a warm sunny day; when they take a little food, and relapse into their former state. These animals seldom appear far from their retreats, or in any open place; for which reason they seem less common in Britain than they really are. They make their nests of moss, grass, and dead leaves; and bring usually three or four young at a time.

15. The quercinus, or garden-squirrel, has a long hairy tail, with a black ring under the eyes. It is a native of the south of Europe, where it lives chiefly in

gardens, though it sometimes is found in houses. They are very destructive to fruit, particularly peaches, which they seem to prefer to every other kind. They also eat pease, apricots, and plumbs; and when soft fruits are not to be had, they will eat almonds, filberts, nuts, and even leguminous plants. Of these they carry off great quantities into their retreats, which they dig in the earth, and particularly in well cultivated gardens; for in old orchards they are often found in hollow trees, where they make beds of herbs, moss, and leaves. Eight or ten of them are frequently found in the same place, all benumbed, and rolled up in the midst of their provision of fruits and nuts. They copulate in spring, and bring forth in summer. The litter consists of five or six young, who grow very quickly, but are not fertile till the next year. Their flesh is not eatable, but has the same disagreeable odour with the domestic rat.

16. The gregarius, or gregarious mouse, has a tail about one-third the length of its body, and somewhat hairy; the body is of a greyish colour, and the legs white. It is a native of Germany and Sweden, is somewhat larger than the common mouse; eats fitting up; burrows, and lives under ground.

17. The sylvaticus, or long-tailed field-mouse, measures, from the end of the nose to the setting on of the tail, four inches and an half; the tail is four inches long; the upper part of the body of a yellowish-brown mixed with some dusky hairs: the breast is of an ochre colour, the rest of the under side is white; the tail is covered with short hair. These animals are found only in fields and gardens; in some places they are called *bean-mice*, from the havoc they make among beans when first sown. They feed also on nuts, acorns, and grain, of which they amass quantities, not proportioned to their wants, but to the capacity of the place where it is deposited, inasmuch that a single animal will collect more than a bushel. Thus they provide for other animals as well as themselves: the hog comes in for a share; and the great damage done to the fields by these creatures, in rooting up the ground, is chiefly owing to their search after the concealed hoards of the field-mice.

The holes of the field-mice are generally more than a foot under ground, and often divided into two apartments, the one for living in with their young, and the other for a magazine. M. Buffon informs us, that he has often seen great damage done to the plantations by these animals. They carry off the new-sown acorns; by following the furrow of the plough, they dig up one after another, not leaving a single seed. This happens chiefly in those seasons when the acorns are scarce; not finding a sufficient quantity in the woods, they come in quest of them in the cultivated fields, and often carry off such quantities that they corrupt in their magazines. These creatures, according to the same author, do more mischief in a nursery of trees than all the birds and other animals put together. The only way to prevent this damage is, to lay traps at ten paces asunder, through the extent of the sown field. No other apparatus is necessary than a roasted walnut placed under a flat stone, supported by a stick. The animals come to eat the walnut, which they prefer to acorns; and as it is fixed to the stick, whenever they touch it, the stone falls down, and crushes

crushes them to death. The same expedient M. Buffon also made use of with success against the short-tailed field-mouse, which also destroys acorns. In this way he found that upwards of 100 were taken each day, from a piece of ground consisting only of about 40 French arpents. From the 15th of November to the 8th of December, above 2000 were caught in this manner. Their numbers gradually diminished till the frost became severe, which is the time they retire into their holes, to feed on their magazines. In autumn they are most numerous; for if provisions fail during the winter, they devour one another. The long-tailed mice eat also the short-tailed species; and even thrushes, blackbirds, &c. which they find entangled in snares. They first eat the brain, and then the rest of the body. M. Buffon once kept a dozen of these mice in a cage, and furnished them with food every morning at eight o'clock. One day they were neglected for about a quarter of an hour, when one of their number was eaten up by the rest; next day another suffered the same fate; and in a few days only one remained: all the others had been killed, and partly devoured; and even the survivor himself had his feet and tail mutilated. These animals are very prolific, producing more than once a year, and bringing nine or ten at a birth. They generally make the nest for their young very near the surface, and often in a thick tuft of grass.

Mr Pennant mentions a species of mouse which he calls the *less long-tailed field-mouse*, or harvest-mouse; and which, he says, is very numerous in Hampshire, particularly during harvest. They form their nest above the ground, between the straws of the standing corn, and sometimes in thistles: it is of a round shape, and composed of the blades of corn. They bring about eight young ones at a time. These never enter houses; but are often carried, in the sheaves of corn, into ricks; and 100 of them have frequently been found in a single rick, on pulling it down to be housed. Those that are not thus carried away in the sheaves, shelter themselves during winter under ground, and burrow deep, forming a warm bed for themselves of dead grass. They are the smallest of the British quadrupeds: the length from nose to tail is only two inches and a half; their tail two inches, and the weight one-sixth of an ounce. They are more slender than the other long-tailed field-mouse; and their back of a fuller red, inclining to the colour of a dormouse.

18. The striatus, or streaked mouse, has four toes on the fore-feet, and five on the hind-ones, longitudinal streaks on the body, with white spots. It is a native of India.

19. The longipes has a long covered tail, four toes on the fore-feet, five on the hind-ones, and very long thighs. It is found in the hind-zone, and is mentioned only by Linnæus.

Plate  
CLXXXIV  
fig. 2.

20. The jaculus, or jerboa, inhabits Barbary, Palestine, Egypt, and the deserts between Balfora and Aleppo. The head hath a great resemblance to that of the rabbit; but its eyes are larger, and its ears shorter, higher, and broader, in proportion to its size. The nose is flesh-coloured and naked, and the muzzle is thick and short. The opening of the mouth is very small, the upper jaw broad, and the under jaw narrow and short. The teeth are like those of the rabbit, and the whiskers round the mouth are composed of

long black and white hairs. The fore-feet are extremely short, and never touch the ground: being used only as hands to convey victuals to the mouth. These hands have four fingers armed with claws, and the rudiments of a fifth without any claw. The hind-feet have only three toes, the middle one of which is the longest, and all three are armed with claws. The tail is three times longer than the body, and is covered with small stiff hairs, of the same colour with those on the back; and the extremity of it is garnished with longer, softer, and more bushy hair. The legs are naked and flesh-coloured, as well as the nose and ears. The top of the head and back are covered with reddish hair; and the flanks, the under-part of the head, the throat, the belly, and the insides of the thighs, are white. Below the reins, and near the tail, there is a large, black, transverse band, in the form of a crescent. These animals generally conceal their hands or fore-feet among the hair, so that at first sight they seem to have only two feet. In transporting themselves from place to place, they do not walk, or advance one foot before the other, but leap nimbly to the distance of five or six feet from the ground. When reposing themselves, they sit on their knees, and sleep only during the day. They eat grain and herbage like the hare. Their dispositions are mild, and yet they can never be perfectly tamed. They dig holes in the earth like rabbits, and in a much shorter time. Two that were kept in a house in London, burrowed almost through the brick-wall of the room where they were: they came out of their hole at night for food, and when caught were much fatter and sleeker than when confined to their box. This animal is eaten by the Arabs, who call it the *lamb of the children of Israel*. Bochart thinks it is the *Saphon* of holy writ, and displays a vast deal of learning on the subject.

An animal very much resembling the above is found in Siberia, where it is called *alagaga*. It hath very long transparent ears; long whiskers; five toes on the fore-feet; three on the hind-feet pointing forward, and a fourth behind, about an inch above the heel: the colour of the upper-part of the body is tawny, the lower whitish; in the form of the body, legs, and tail, it agrees with the last. Like the former, this is extremely active; digs holes in the ground with vast agility with its fore-feet; tears the roots with its teeth, and flings back the earth with its hind-feet: if pursued, and finds it cannot escape by leaping, attempts to make a new hole: in some places there are so thick as to be dangerous to travellers, the horses perpetually falling in them. It provides against winter; cuts grass, and leaves it in heaps a foot square to dry, afterwards carrying it into the burrow.

Besides these, M. Buffon describes an animal which probably belongs to the same species, and which he calls the *tarfser*, or woolly jerboa; but says, he accidentally procured it from a person who could neither tell its name, nor from whence it came. It had a sharp-pointed nose; long, erect, naked, transparent ears; large eyes; two cutting teeth in each jaw; and, what is peculiar to this species, two canine teeth in each: it had five long slender fingers on each foot, resembling those of a monkey: the fore-legs moderately long; the hind-legs of a very remarkable length,

Mufa. length, especially the second bone; that next the foot slender and naked; the tail exceedingly long and slender; the hair on the body long, soft, and woolly; the head of an ash-colour; the rest of the body tawny, mixed with an ash-colour: it was larger than a common mouse.

21. The volans, has a long hairy tail; four toes on the fore-feet, and five on the hind ones; and the skin from the ears to the tail is extended like wings, by which means it is enabled to fly. It is a native of Virginia and Mexico.

MUSA, the PLANTAIN-TREE; a genus of the monœcia order, belonging to the polygama class of plants. The most remarkable species are, 1. The *paradisæica*, or plantain. 2. The *musæ sapientum*, or banana-tree.

The first sort is cultivated in all the islands of the West Indies, where the fruit serves the Indians for bread; and some of the white people also prefer it to most other things, especially to the yams and cassia bread. The plant rises with a soft herbaceous stalk, 15 or 20 feet high; the lower part of the stalk is often as large as a man's thigh, diminishing gradually to the top, where the leaves come out on every side; these are often six feet long, and near two feet broad, with a strong fleshy midrib, and a great number of transverse veins running from the midrib to the borders. The leaves are thin and tender, so that where they are exposed to the open air, they are generally torn by the wind; for as they are large, the wind has great power against them: these leaves come out from the centre of the stalk, and are rolled up at their first appearance; but when they are advanced above the stalk, they expand and turn backward: as these leaves come up rolled in the manner before-mentioned, their advance upward is so quick, that their growth may almost be discerned by the naked eye; and if a fine line is drawn across, level with the top of the leaf, in an hour's time the leaf will be near an inch above it. When the plant is grown to its full height, the spikes of flowers will appear in the centre, which is often near four feet in length, and nods on one side. The flowers come out in bunches, those in the lower part of the spike being the largest, the others diminish in their size upward; each of these bunches is covered with a spathe or sheath of a fine purple colour, which drops off when the flowers open. The upper part of the spike is made up of male or barren flowers, which are not succeeded by fruit, but fall off with their covers. The fruit of this is eight or nine inches long, and above an inch diameter, a little incurved, and has three angles; it is at first green, but when ripe of a pale-yellow colour. The skin is tough, and within is a soft pulp of a luscious sweet flavour. The spikes of fruit are often so large as to weigh upwards of 40 lb. The fruit of this sort is generally cut before it is ripe, roasted in the embers, and eaten instead of bread. The leaves are used for napkins and table-cloths, and are food for hogs.

The second sort differs from the first, in having its stalks marked with dark purple stripes and spots. The fruit is shorter, straighter, and rounder: the pulp is softer, and of a more luscious taste; so is generally eaten by way of desert, and seldom used in the same

way as the plantain, therefore is not cultivated in such plenty.

Both these plants were carried to the West Indies from the Canary Islands, to which place it is believed they were carried from Guinea, where they grow naturally. They are also cultivated in Egypt, and in most other hot countries, where they grow to perfection in about 10 months, from their first planting to the ripening of their fruit: when their stalks are cut down, there will several suckers come up from the root, which in six or eight months will produce fruit; so that by cutting down the stalks at different times, there is a constant succession of fruit all the year.

In Europe there are some of these plants preserved in the gardens of curious persons, who have hot-houses capacious enough for their reception, in many of which they have ripened their fruit very well; but as they grow very tall, and their leaves are large, they require more room in the stove than most people care to allow them. They are propagated by suckers, which come from the roots of those plants which have fruited; and many times the younger plants, when they are stunted in growth, will put out suckers; these should be carefully taken off, preserving some fibres to their roots, and planted in pots filled with light rich earth, and plunged into the tan-bed in the stove: they may be taken off any time in summer; and it is best to take them off when young, because if their roots are grown large, they do not put out new fibres so soon; and when the thick part of the root is cut in taking them off, the plants often rot.

During the summer-season these plants must be plentifully watered; for the surface of their leaves being large, there is a great consumption of moisture by perspiration in hot weather; but in the winter they must be watered more sparingly, though at that season they must be often refreshed, but it must not be given them in such quantities.

The pots in which these plants are placed should be large, in proportion to the size of the plants; for their roots generally extend pretty far, and the earth should be rich and light. The degree of heat with which these plants thrive best, is much the same with the anana or pine-apple, in which Mr Miller had many of these plants produce their fruit in perfection, and they were near 20 feet high.

The most sure method to have these plants fruit in Britain is, after they have grown some time in pots, so as to have made good roots, to shake them out of the pots with the ball of earth to their roots, and plant them into the tan-bed in the stove, observing to lay a little old tan near their roots for their fibres to strike into; and in a few months the roots will extend themselves many feet each way in the bark; and these plants will thrive a great deal faster than those which are confined in pots or tubs. When the bark-bed wants to be renewed with fresh tan, there should be great care taken of the roots of the plants, not to cut or break them, as also to leave a large quantity of the old tan about them; because if the new tan is laid too near them, it will search their roots, and injure them. If the plants push out their flower-stems in the spring, there will be hopes of their perfecting their fruit; but when they come out late in the year, the plants will sometimes decay before the fruit is ripe. The



flowers in which they are placed should be at least 20 feet in height, otherwise there will not be room for their leaves to expand: for when the plants are in vigour, the leaves are often eight feet in length, and near three feet broad; so that if the stems grow to be 14 feet to the division of the leaves, and the house is not 20 feet high, the leaves will be cramped, which will retard the growth of the plant: besides, when the leaves are bent against the glass, there will be danger of their breaking them when they are growing vigorously; for, in one night, the stems of such bent leaves have been known to force through the glass, and by the next morning were advanced two or three inches above it.

The fruit of the banana-tree is four or five inches long, of the size and shape of a middling cucumber, and of a high, grateful flavour; the leaves are two yards long, and a foot broad in the middle; they join to the top of the body of the tree, and frequently contain in their cavities a great quantity of water, which runs out, upon a small incision being made into the tree, at the junction of the leaves. Bananas grow in great bunches, that weigh a dozen pounds and upwards. The body of the tree is so porous, as not to merit the name of wood; the tree is only perennial by its roots, and dies down to the ground every autumn.

When the natives of the West Indies, says Labat, undertake a voyage, they make provision of a paste of banana; which, in case of need, serves them for nourishment and drink: for this purpose, they take ripe bananas, and, having squeezed them thro' a fine sieve, form the solid fruit into small loaves, which are dried in the sun or in hot ashes, after being previously wrapped up in the leaves of Indian flowering-reed. When they would make use of this paste, they dissolve it in water, which is very easily done; and the liquor, thereby rendered thick, has an agreeable acid taste imparted to it, which makes it both refreshing and nourishing.

The banana is greatly esteemed, and even venerated, by the natives of Madeira, who term it the *forbidden fruit*, and reckon it a crime almost inexpiable to cut it with a knife; because, after dissection, it exhibits, as they pretend, a similitude of our Saviour's crucifixion; and to cut the fruit open with a knife, is, in their apprehension, to wound his sacred image.

Some authors have imagined, that the banana-tree was that of the leaves of which our first parents made themselves aprons in Paradise. The sacred text, indeed, calls the leaves employed for that purpose *fig-leaves*; and Milton, in a most beautiful but erroneous description, affirms the bearded or Bengal fig to have been the tree alluded to. But, besides that the fruit of the banana is often by the most ancient authors called a *fig*, its leaves, by reason of their great size and solidity, were much more proper for a veil or covering than those of the Bengal fig, which are seldom above six or eight inches long and three broad. On the other hand, the banana leaves being three, four, and five feet long, and proportionally broad, could not fail to be pitched upon in preference to all others; especially as they might be easily joined, or sewed together, with the numerous thread-like filaments, that may, with the utmost facility, be peeled from the body of this tree.

MUSÆUS, an ancient Greek poet, was, according to Plato and Diodorus Siculus, an Athenian, the son of Orpheus, and chief of the Eleusinian mysteries instituted at Athens in honour of Ceres: or, according to others, he was only the disciple of Orpheus; but, from the great resemblance which there was between his character and talents and those of his master, by giving a stronger outline to the figure he was called his *son*, as those were styled the *children of Apollo* who cultivated the arts of which he was the tutelary god.

Musæus is allowed to have been one of the first poets who versified the oracles. He is placed in the Arundelian marbles, epoch 15. 1426 B. C. at which time his hymns are there said to have been received in the celebration of the Eleusinian mysteries. Laertius tells us, that Musæus not only composed a theogony, but formed a sphere for the use of his companions; yet as this honour is generally given to Chiron, it is more natural to suppose, with Sir Isaac Newton, that he enlarged it with the addition of several constellations after the conquest of the golden fleece. The sphere itself shews that it was delineated after the Argonautic expedition, which is described in the aëterisms, together with several other more ancient histories of the Greeks, and without any thing later; for the ship *Argo* was the first long vessel which they had built: hitherto they had used round ships of burthen, and kept within sight of the shore; but now, by the dictates of the oracle, and consent of the princes of Greece, the flower of that country sail rapidly thro' the deep, and guide their ship by the stars.

Musæus is celebrated by Virgil in the character of hierophant, or priest of Ceres, at the head of the most illustrious mortals who have merited a place in Elysium. Here he is made the conductor of Æneas to the recess where he meets the shade of his father Anchises.

A hill near the citadel of Athens was called *Musæum*, according to Pausanias, from Musæus, who used to retire thither to meditate and compose his religious hymns; at which place he was afterwards buried. The works which went under his name, like those of Orpheus, were by many attributed to Onomacritus. Nothing remains of this poet now, nor were any of his writings extant in the time of Pausanias, except a hymn to Ceres, which he made for the Lycomides. And as these hymns were likewise set to music, and sung in the mysteries by Musæus himself in the character of priest, he thence perhaps acquired from future times the title of *musician* as well as of *poet*; the performance of sacred music being probably at first confined to the priesthood in these celebrations, as it had been before in Egypt, whence they originated. However, he is not enumerated among ancient musicians by Plutarch; nor does it appear that he merited the title of *son* and *successor to Orpheus* for his musical abilities, so much as for his poetry, piety, and profound knowledge in religious mysteries.

MUSCA, or GNAT, in zoology; a genus of insects, belonging to the order of diptera. The mouth is furnished with a fleshy proboscis, and two lateral lips; it has no pappi. There are 129 species, principally distinguished by the peculiarities in their feelers.

Burney's  
Hist. of  
Musæus.

Muscadine,  
Musc.

MUSCADINE, a rich wine, of the growth of Provence, Languedoc, Ciudad, &c.—The word, as well as the liquor, is French: some fetch its original from *musik*; the wine being supposed to have a little of the smell of that perfume: others from *musca*, a “fly,” because the flies are extremely fond of its grapes; as the Latins had their *vinum apianum*, so called *ab apibus*, from the bees which fed on it.

The way of making muscadine at Frontignac is as follows: They let the muscadine grapes grow half dry on the vine; as soon as they are gathered, they tread and press them immediately, and tun up the liquor, without letting it stand and work in the fat; the lee occasioning its goodness.

MUSCI, Mosses, one of the seven families or classes into which all vegetables are divided by Linnæus in the *Philosophia Botanica*. The characteristics of these plants, according to the sexual system, are,

1. Tops, without filaments or threads. 2. The male flower, constituted by the presence of the *antheræ* or tops, placed apart from the female, either on the same or distinct roots. 3. The female flowers deprived of the  *pistillum*, or pointal. 4. The seeds devoid of both lobes (*cotyledones*), and proper coverings; so that they exhibit the naked embryo.

This tribe of plants, as well as the mushrooms, ferns, and sea-weed, is still imperfectly known. Dillenius, professor of botany at Oxford, was the first who attempted an arrangement of them. In his *Catalogus Plantarum circa Giffam* published at Francfort in 1719, and afterwards in his *Historiâ Muscorum* published at Oxford in 1741, he divides the mosses into 16 genera. This arrangement, however, includes the lichens, some of the fungi, and other plants which belong to very different families. The work in question is, notwithstanding, valuable, in having introduced the knowledge of upwards of 200 plants, which were unknown before Dillenius: it is, besides, of all his works of this kind, the best executed, both for the descriptions and figures, and should serve as a model to such authors as intend to publish in detail the history of any particular family of plants.

Micheli, in a work intitled *Nova Plantarum Genera*, published at Florence in folio in 1629, divides the mosses into two sections, from the figure and situation of their flowers. These sections comprehend together 16 genera, amongst which are improperly arranged, like those of Dillenius, several of the lichens and other sea-weed.

The discovery of the seeds of the mosses, though made by Dillenius in 1719, is arrogated by Linnæus to himself, who did not begin to write till 1735.

In Ray's method, the mosses form the third class: in Tournefort's, they constitute a single genus, by the name of *muscus*, in the first section of the 17th class, which comprehends the mosses, mushrooms, and some of the algæ or sea-weed, and is distinguished by the name of *aspermæ*, or plants without seed; the seeds of the mosses not having been detected by Tournefort.

In the sexual system, these plants constitute the second order of the class *cryptogamia*, which contains all the plants in which the parts of the flower and fruit are wanting, or not conspicuous. This order is subdivided into 11 genera, from the presence or absence of the calix, which, in these plants, is a veil or cover,

like a monk's cawl, that is placed over the male organs, or tops of the stamina, and is denominated *calyx*; and from the sexes of the plants, which bear male and female flowers, sometimes on the same, sometimes on distinct roots; and from the manner of growth of the female flowers, which are sometimes produced singly, sometimes in bunches or cones. These distinctions are mostly borrowed from Dillenius, whose excellence in developing this part of the vegetable kingdom Linnæus very readily acknowledges.

MUSCI, is likewise the name of the 56th order in Linnæus's Fragments of a Natural Method. See BOTANY, p. 1317.

MUSCICAPA, or FLY-CATCHER, a genus of birds belonging to the order of passerif. The most remarkable species is the grifola, or spotted fly-catcher. It is a bird of passage, appears in the spring, breeds with us, and retires in August. It builds its nest on the sides of trees, towards the middle: Morton says, in the corners of walls where spiders weave their webs. Mr Pennant has seen them followed by four or five young, but never saw their eggs. When the young can fly, the old ones withdraw with them into thick woods, where they frolic among the top-branches; dropping from the boughs frequently quite perpendicular on the flies that sport beneath, and rise again in the same direction. It will also take its stand on the top of some stake or post, from whence it springs forth on its prey, returning still to the same stand for many times together. They feed also on cherries, of which they seem very fond.

The head is large, of a brownish hue spotted obscurely with black: the back of a mouse-colour: the wings and tail dusky; the interior edges of the quill-feathers edged with pale yellow: the breast and belly white; the shafts of the feathers on the former dusky; the throat and sides under the wings are dashed with red: the bill is very broad at the base, is ridged in the middle, and round the base are several short bristles: the inside of the mouth is yellow: the legs and feet are short and black.

MUSCLE, in anatomy. See there, p. 363.

MUSCLE, in natural history. See MYRULUS.

MUSEUM, a name which originally signified a part of the palace of Alexandria, which took up at least one-fourth of the city. This quarter was called the *museum*, on account of its being set apart for the muses and the study of the sciences. Here were lodged and entertained the men of learning; who were divided into many companies or colleges, according to the sciences of which they were the professors; and to each of these houses or colleges was allotted a handsome revenue. The foundation of this establishment is attributed to Ptolemy Philadelphus, who here placed his library. Hence the word *museum* is now applied to any place set apart as a repository for things that have an immediate relation to the arts.

The museum at Oxford, called the *Ashmolean museum*, is a noble pile of building, erected at the expense of the university, at the west end of the theatre, at which side it has a magnificent portal, sustained by pillars of the Corinthian order. The front, which is to the street, extends about 60 feet, where there is this inscription over the entrance in gilt characters, *Museum Ashmoleanum, schola naturalis historie, officina chymica*.

Muscil  
Muscum

Fig. 1. MUSTELA PUTORIUS or Polecat.



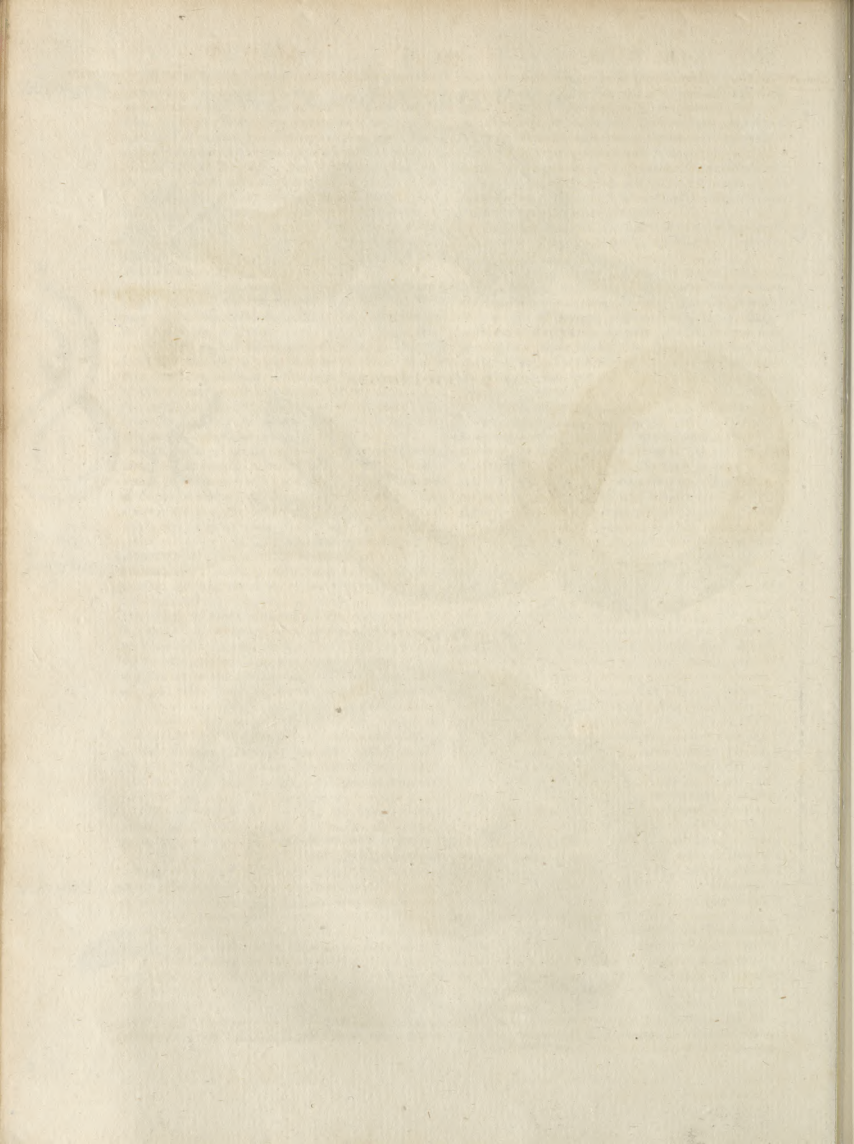
Fig. 2. MUD-INGUINA



Fig. 4. MYRMECOPHAGA.



Fig. 3. MUSTELA ERMINA or Ermine.



*Museum. chymica.* It was begun in 1679, and finished in 1683, when a valuable collection of curiosities was presented to the university by Elias Ashmole, Esq; which were the same day deposited there: several accessions have been since made to the museum; among which are hieroglyphics, and other Egyptian antiquities, an entire mummy, Roman antiquities, altars, medals, lamps, &c. and a variety of natural curiosities.

The British museum in London is a large, beautiful, and magnificent building, the noblest cabinet of curiosities in the world. This edifice was erected in 1677; and was called *Montague-houfe*, from having been the town-residence of the dukes of Montague. In the year 1753, the British parliament, having passed an act for purchasing the museum of the late Sir Hans Sloane, and the collection of manuscripts of the late Lord Oxford, called the *Harleian library*, for the use of the public, 26 trustees were appointed and incorporated, to provide a repository for those and some other collections, which repository was to be called the *British museum*. These trustees elected 15 other trustees; and, having bought Montague-houfe, fitted it up for the reception of these collections: they also appointed officers to superintend the museum; and having ordained certain statutes with respect to viewing the collection contained in it, the public were admitted to view it in 1757. Among the curiosities contained in the Museum are the following:

The library of Sir Hans Sloane, including books of drawings, manuscripts, and prints, in vols	50,000
Medals and coins, ancient and modern	23,000
Cameo's and istaglio's, about	700
Scales	268
Vessels of agate, jasper, &c.	542
Antiquities	1125
Precious stones, agates, jaspers, &c.	2256
Metals, minerals, ores, &c.	2725
Crytalls, spars, &c.	1864
Fossils, flints, stones	1275
Earths, sands, salts	1035
Bitumens, sulphurs, ambers, &c.	399
Tales, micæ, &c.	388
Corals, sponges, &c.	1421
Testacea, &c.	5843
Echini, echinitæ, &c.	659
Asterizæ, trochi, enterochi	241
Crustaceæ, crabs, lobsters, &c.	363
Stellæ marinæ, star-fishes, &c.	173
Fishes and their parts	1555
Birds and their parts, eggs, and nests of different species	1172
Quadrupeds, &c.	1886
Vipers, serpents, &c.	521
Insects, &c.	5439
Vegetables	12,506
Volumes of dried plants	334
Calculi, anatomical preparations, &c.	756
Miscellaneous things natural	2098
Mathematical instruments	55

Fifteen persons are allowed to view it in one company; the time allotted is two hours; and when any

number, not exceeding 15, are inclined to see it, they must send a list of their Christian names and surnames, additions, and places of abode, to the porter's lodge, in order to their being entered in the book: in a few days the respective tickets will be made out, specifying the day and hour when they are to come; which, on being sent for, will be delivered. If by any accident some of the parties are prevented from coming, it is proper they send their ticket back to the lodge, as no body can be admitted with it but themselves. It is, to be remarked, that the fewer names there are in a list, the sooner they are likely to be admitted to see it.

MUSES, certain fabulous deities among the Pagans, supposed to preside over the arts and sciences: for this reason it is usual for the poets, at the beginning of a poem, to invoke these goddesses to their aid.

The muses were originally only fingers and musicians in the service of Osiris, or the great Egyptian Bacchus, under the instruction and guidance of his son Orus; but in succeeding times they were called the *daughters of Jupiter and Mnemosyne* or *Memory*.

These are the only pagan divinities whose worship has been continued through all succeeding changes in the religion and sentiments of mankind. Professors of every liberal art in all the countries of Europe still revere them; particularly the poets, who seldom undertake the slightest work without invoking their aid.

Sir Isaac Newton tells us, that the singing women of Osiris were celebrated in Thrace by the name of the *musæ*; and that the daughters of Pieros, a Thracian, imitating them, were celebrated by the same name.

Diodorus Siculus informs us, that Alcman of Messene, a lyric poet who flourished in the 27th Olympiad, 670 years B. C. makes them the daughters of Uranus and Terra. It has been asserted by some ancient writers, that at first they were only three in number; but Homer, Hesiod, and other profound mythologists, admit of nine (A).

In his hymn to Apollo, Homer says,

—By turns the nine delight to sing.

And Hesiod, in his theogony, names them all. They are said severally to preside over some art or science, as music, poetry, dancing, astronomy. By some they are called *virgins*, because the virtues of education appear unalterable: they are called *musæ* from a Greek word which signifies to explain myths, because they have taught things the most curious and important to know, and which are above the comprehension of vulgar minds. Each of their names is said to include some particular allegory; *Clio*, for instance, has been thus called, because those who are praised in verse acquire immortal fame; *Euterpe*, on account of the pleasure accruing to those who hear learned poetry; *Thalia* implies for ever flourishing; *Melpomene*, that her melody insinuates itself into the inmost recesses of the soul; *Terpsichore* marks the plea-

(A) It has been said, that when the citizens of Sicyon directed three skilful statuarys to make each of them statues of the three Muses, they were all so well executed, that they did not know which to choose; but erected all the nine, and that Hesiod and Homer only gave them names.

Muses,  
Musgrave.

pleasure which those receive who are versed in the liberal arts; *Erato* seems to indicate, that the learned command the esteem and friendship of all mankind; *Polyhymnia*, that many poets are become immortal by the number of hymns which they have addressed to the gods; *Urania*, that those whom the instructs elevate their contemplations and celebrity to the heavens and the stars; and lastly, the exquisite voice of *Calliope* has acquired her that appellation, as the inventress and guardian of eloquence and rhetoric.

An epigram of Callimachus gives the attributes of the muses in as many lines.

*Calliope* the deeds of heroes sings;  
Great *Clio* sweeps to history the strings;  
*Euterpe* teaches mimes their silent show;  
*Melpomene* presides o'er scenes of wo;  
*Terpsichore* the flute's soft pow'r displays;  
And *Erato* gives hymns the gods to praise;  
*Polymnia's* skill inspires melodious strains;  
*Urania* wise, the starry course explains;  
And gay *Thalia's* glass points out where folly reigns. }

This epigram does not, however, exactly correspond with the ideas of other poets, or of the ancient painters, in characterizing the attributes of the muses. The ancients had numberless ingenious and fanciful ideas concerning the muses. Fulgentius informs us, from the testimony of various ancient authors, that Apollo was painted with a cithara of ten strings, as a symbol of the union of the god with the nine muses, and to shew that the human voice is composed of ten parts; of which the four first are the front-teeth, placed one against the other, so useful for the appulse of the tongue in forming sounds, that, without any one of them, a whistle would be produced instead of a voice; the fifth and sixth are the two lips, like cymbals, which, by being struck against each other, greatly facilitate speech; the seventh is the tongue, which serves as a plectrum to articulate sounds; the eighth is the palate, the concave of which forms a belly to the instrument; the ninth is the throat, which performs the part of a flute; and the tenth the lungs, which supply the place of bellows.

Pythagoras, and afterwards Plato, make the muses the soul of the planets in our system; from whence the imaginary music of the spheres.

MUSGRAVE (Dr William), a learned physician

and antiquary, was born at Charlton-Musgrave in <sup>Musgrave,</sup> <sup>Musgrave,</sup> Somersetshire, about the year 1657; and studied at New-college, Oxford. Having distinguished himself by his knowledge in his profession, and his skill in natural philosophy, he was elected fellow of the Royal Society; and being made secretary in 1684, he continued the Philosophical Transactions from n<sup>o</sup> 167 to n<sup>o</sup> 178 inclusive. After having taken his degrees in physic, and being admitted a fellow of the college of physicians, he went and settled at Exeter, where he practised physic with great reputation and success. Being a man of extensive learning, he composed, at his leisure-hours, several curious and valuable works; as, 1. *De arthritide anomala sive interna dissertatio*. 2. *De arthritide symptomatica dissertatio*. 3. *Julii Vitalis epitaphium, cum commentario*. 4. *De legionibus epistola*. 5. *De aquilis Romanis epistola*. 6. *Inscriptio Terraconensis, cum commentario*. 7. *Geta Britannicum, &c.* 8. *Belgium Britannicum*. This learned physician died in 1721.

MUSHROOM, in botany. See AGARICUS and FUNGUS.—Physicians have disputed much about the qualities of mushrooms; some considering them as a rich nourishment, and perfectly innocent, when properly chosen; and others asserting them to be extremely deleterious. Most of the fungi are indeed of a hurtful quality; and, with respect to the whole tribe, the esculent are very few. Esculent mushrooms are very nutritive, very readily alkalescient, and more so without intermediate acescency than any other vegetable: they are therefore a rich nourishment, and much akin to animal-food; on which account they may be indulged in considerable quantity to strong persons. It requires, however, skill to distinguish this esculent kind; and very few, especially of those who are commonly employed to gather them, viz. the servants, have studied Clusius, or other authors who have been at the pains to distinguish them. Perhaps our esculent mushrooms, if old, acquire a dangerous acrimony; and for these reasons Dr Cullen is of opinion that it is for the most part prudent to avoid them. In the warmer climates they may be used as light food; but here it is preposterous to use them along with animal-food, as they do not correct its alkaline tendency.

## M U S I C ;

THE art of combining sounds in a manner agreeable to the ear. This combination may be either simultaneous or successive; in the first case, it constitutes harmony; in the last, melody. But though the same sounds, or intervals of sound, which give pleasure when heard in succession, will not always produce the same effect in harmony; yet the principles which constitute the simpler and more perfect kinds of harmony, are almost, if not entirely, the same with those of melody. By *perfect harmony*, we do not here mean that plenitude, those complex modifications of harmonic sound which are admired in practice; but that harmony which is called *perfect* by theoreticians and artists; that harmony which results from the coalescence of simultaneous sounds produced by vibrations in the proportions of thirds, fifths, and octaves, or their duplicates.

The principles upon which these various combinations of sound are founded, and by which they are regulated, constitute a science, which is not only extensive but profound, when we would investigate the principles from whence these happy modifications of sound result, and by which they are determined; or when we would explore the sensations, whether mental or corporeal, with which they affect us. The ancient definitions of music are not proportioned in their extent to our present ideas of that art; but M. Rousseau betrays a temerity highly inconsistent with the philosophical character, when from thence he infers, that their ideas were vague and undetermined. Every soul susceptible of refinement and delicacy in taste or sentiment, must be conscious that there is a music in action as well as in sound; and that the ideas of beauty and decorum, of harmony and symmetry, are, if we may use the expression, equally constituent of visible as of audible music. These illustrious minds, whose comprehensive prospects in every science where taste and propriety prevail took in nature at a single glance, would behold with contempt and ridicule those narrow and microscopic views of which alone their successors in philosophy have discovered themselves capacious. With these definitions, however, we are less concerned, as they bear no proportion to the ideas which are now entertained of music. Nor can we follow M. Rousseau, from whatever venerable sources his authority may be derived, in adopting his Egyptian etymology for the word *music*. The established derivation from *Musa* could only be questioned by a paradoxical genius. Is the fact sufficiently authenticated, that music had been practised in Egypt before it was known in Greece? And though it were true, would it follow from thence, that the Greeks had borrowed the name as well as the art from Egypt? If the art of music be so natural to man that vocal melody is practised wherever articulate sounds are used, there can be little reason for deducing the idea of music from the whistling of winds through the reeds that grew on the river Nile. And indeed, when we reflect with how easy a transition we may pass from the accents of speaking to diatonic sounds, when we observe how early children adapt the

language of their amusements to measure and melody however rude, when we consider how early and universally these practices take place, there is no avoiding the conclusion, that the idea of music is connatural to man, and implied in the original principles of his constitution. We have already said, that the principles on which it is founded, and the rules by which it is conducted, constitute a science. The same maxims when applied to practice form an art: hence its first and most capital division is into *speculative* and *practical* music.

*Speculative* music is, if we may be permitted to use the expression, the knowledge of the nature and use of those materials which compose it; or, in other words, of all the different relations between the high and low, between the harsh and the sweet, between the swift and the slow, between the strong and the weak, of which sounds are susceptible; relations which, comprehending all the possible combinations of music and sounds, seem likewise to comprehend all the causes of the impressions which their succession can make upon the ear and upon the soul.

*Practical* music is the art of applying and reducing to practice those principles which result from the theory of agreeable sounds, whether simultaneous or successive; or, in other words, to conduct and arrange sounds according to the proportions resulting from consonance, from duration and succession, in such a manner as to produce upon the ear the effect which the composer intends. This is the art which we call *composition* \*. \* See Composition. With respect to the actual production of sounds by voices or instruments, which is called *execution*, this department is merely mechanical and operative; which, only presupposing the powers of sounding the intervals true, of exactly proportioning their degrees of duration, of elevating or depressing sounds according to these gradations which are prescribed by the tone, and to the value required by the time, demands no other knowledge but a familiar acquaintance with the characters used in music, and a habit of expressing them with promptitude and facility.

*Speculative* music is likewise divided into two departments; viz. the knowledge of the proportions of sounds or their intervals, and that of their relative durations; that is to say, of measure and of time.

The first is what among the ancients seems to have been called *harmonical* music. It shews in what the nature of air or melody consists; and discovers what is consonant or discordant, agreeable or disagreeable, in the modulation. It discovers, in a word, the effects which sounds produce in the ear by their nature, by their force, and by their intervals; which is equally applicable to their consonance and their succession.

The second has been called *rhythmical*, because it treats of sounds with regard to their time and quantity. It contains the explication of their continuance, of their proportions, of their measures whether long or short, quick or slow, of the different modes of time and the parts into which they are divided, that to these the succession of sounds may be conformed.

*Practical* music is likewise divided into two departments, [ a ]

ments, which correspond to the two preceding.

That which answers to *harmonical* music, and which the ancients called *melopée*, teaches the rules for combining and varying the intervals, whether consonant or dissonant, in an agreeable and harmonious manner.

The second, which answers to the *rhythmical* music, and which they called *rhythopée*, contains the rules for applying the different modes of time, for understanding the feet by which verses were scanned, and the diversities of measure; in a word, for the practice of the rhythmus.

Music is at present divided more simply into *melody* and *harmony*; for since the introduction of *harmony* the proportion between the length and shortness of sounds, or even that between the distance of returning cadences, are of less consequence amongst us. For it often happens in modern languages, that the verses assume their measures from the musical air, and almost entirely lose the small share of proportion and quantity which in themselves they possess.

By melody the successions of sound are regulated in such a manner as to produce pleasing airs\*.

\* See  
Melody.

Harmony consists in uniting to each of the sounds, in a regular succession, two or more different sounds, which simultaneously striking the ear soothe it by their concurrence. See HARMONY.

Music, according to Rousseau, may be, and perhaps likewise ought to be, divided into the *physical* and the *imitative*. The first is limited to the mere mechanism of sounds, and reaches no further than the external senses, without carrying its impressions to the heart, and can produce nothing but corporeal sensations more or less agreeable. Such is the music of songs, of hymns, of all the airs which only consist in combinations of melodious sounds, and in general all music which is merely harmonious.

It may, however, be questioned whether every sound, even to the most simple, is not either by nature, or by early and confirmed association, *imitative*. If we may trust our own feelings, there is no such thing in nature as music which gives mechanical pleasure alone. For if so, it must give such pleasure as we receive from tastes, from odours, or from other grateful titillations; but we absolutely deny that there are any musical sensations or pleasures in the smallest degree analogous to those. Let any piece of music be resolved into its elementary parts and their proportions, it will then easily appear from this analysis, that sense is no more than the vehicle of such perceptions, and that mind alone can be susceptible of them. It may indeed happen, from the number of the performers and the complication of the harmony, that meaning and sentiment may be lost in the multiplicity of sounds; but this, though it may be harmony, loses the name of *music*.

The second department of his division, by lively and accentuated inflections, and by sounds which may be said to speak, expresses all the passions, paints every possible picture, reflects every object, subjects the whole of nature to its skilful imitations, and impresses even on the heart and soul of man sentiments proper to affect them in the most sensible manner. This, continues he, which is the genuine lyric and theatrical music, was what gave double charms and energy to ancient poetry; this is what, in our days, we exert ourselves in applying to the drama, and what

our fingers execute on the stage. It is in this music alone, and not in harmonics or the resonance of nature, that we must expect to find accounts of those prodigious effects which it formerly produced.

But, with Mr Rousseau's permission, all music which is not in some degree characterized by these pathetic and imitative powers, deserves no better name than that of a *musical jargon*, and can only be effectuated by such a complication and intricacy of harmony, as may confound, but cannot entertain the audience. This character, therefore, ought to be added as essential to the definition of music; and it must be attributed to our neglect of this alone, whilst our whole attention is bestowed on harmony and execution, that the best performances of our artists and composers are heard with listless indifference and ostentation, nor ever can conciliate any admirers, but such as are induced, by pedantry and affectation, to pretend what they do not feel. Still may the curse of indifference and inattention pursue and harrow up the souls of every composer or performer, who pretends to regale our ears with this musical legerdemain, till the grin of scorn, or the hiss of infamy, teach them to correct this depravity of taste, and entertain us with the voice of nature!

Whilst moral effects are sought in the natural effects of sound alone, the scrutiny will be vain, and disputes will be maintained without being understood: but sounds, as representatives of objects, whether by nature or association, introduce new scenes to the fancy and new feelings to the heart; not from their mechanical powers, but from the connection established by the Author of our frame between sounds and the objects which either by natural resemblance or unavoidable association they are made to represent.

It would seem that music was one of those arts which were first discovered; and that vocal was prior to instrumental music, if in the earliest ages there was any music which could be said to be purely instrumental. For it is more than probable, that music was originally formed to be the vehicle of poetry; and of consequence, though the voice might be supported and accompanied by instruments, yet music was never intended for instruments alone.

We are told by ancient authors, that all the laws whether human or divine, exhortations to virtue, the knowledge of the characters and actions of gods and heroes, the lives and achievements of illustrious men, were written in verse, and sung publicly by a quire to the sound of instruments; and it appears from the Scriptures, that such from the earliest times was the custom among the Israelites. Nor was it possible to find means more efficacious for impressing on the mind of man the principles of morals, and inspiring the love of virtue. Perhaps, however, this was not the result of a premeditated plan; but inspired by sublime sentiments and elevation of thought, which in accents that were suited and proportioned to their celestial nature endeavoured to find a language worthy of themselves and expressive of their grandeur.

It merits attention, that the ancients were so sensible of the value and importance of this divine art, not only as a symbol of that universal order and symmetry which prevails through the whole frame of material and intelligent nature, but as productive of the most momentous effects both in moral and political life.



life. Plato and Aristotle, who disagreed almost in every other maxim of politics, are unanimous in their approbation of music, as an efficacious instrument in the formation of the public character and in conducting the state; and it was the general opinion, that whilst the gymnastic exercises rendered the constitution robust and hardy, music humanized the character, and softened those habits of roughness and ferocity by which men might otherwise have degenerated into savages. The gradations by which voices were exerted and tuned, by which the invention of one instrument succeeded to another, or by which the principles of music were collected and methodized in such a manner as to give it the form of an art and the dignity of a science, are topics so fruitful of conjecture and so void of certainty, that we must leave them to employ minds more speculative and inventions more prolific than ours, or transfer them to the *History of Music* as a more proper place for such disquisitions. For the amusement of the curious, Rousseau in his *Musical Dictionary*, Plates C and N, has transcribed some fragments of Grecian, Persian, American, Chinese, and Swiss music, with which performers may entertain themselves at leisure. When they have tried the pieces, it is imagined they will be less faintly fond than that author of ascribing the power of music to its affinity with the national accents where it is composed. This may doubtless have its influence; but there are other causes more permanent and less arbitrary to which it owes its most powerful and universal charms.

The music now most generally celebrated and practised is that of the Italians, or their successful imitations. The English, from the invasion of the Saxons, to that more late tho' lucid æra in which they imbibed the art and copied the manner of the Italians, had a music which neither pleased the soul nor charmed the ear. The primitive music of the French deserves no higher panegyric. Of all the barbarous nations, the Scots and Irish seem to have possessed the most affecting original music. The first consists of a melody characterised by tenderness: it melts the soul to a pleasing pensive languor. The other is the native expression of grief and melancholy. Tassoni informs us, that in his time a prince from Scotland had imported into Italy a lamentable kind of music from his own country; and that he himself had composed pieces in the same spirit. From this expressive, though laconic description, we learn, that the character of our national music was even then established; yet so gross is our ignorance and credulity, that we ascribe the best and most impassioned airs which are extant among us to David Rizzio; as if an Italian Lutanist, who had lived so short a time in Scotland, could at once, as it were by inspiration, have imbibed a spirit and composed in a manner so different from his own. It is yet more surprising that Geminiani should have entertained and published the same prejudice, upon the miserable authority of popular tradition alone; for the fact is authenticated by no better credentials. The primitive music of the Scots may be divided into the *marchal*, the *pastoral*, and the *festive*. The *first* consists either in marches, which were played before the chieftains, in imitation of the battles which they fought, or in lamentations for the catastrophes of war and the extinction of families. These wild effusions of natural me-

lody preserve several of the rules prescribed for composition. The strains, though rude and untutored, are frequently terrible or mournful in a very high degree. The part or march is sometimes common, sometimes in treble time; regular in its measures, and exact in the distance between its returning cadences; most frequently, though not always, loud and brisk. The *piroch*, or imitation of battles, is wild, and abrupt in its transitions from interval to interval and from key to key; various and desultory in its movements; frequently irregular in the return of its cadences; and in short, through the whole, seems inspired with such fury and enthusiasm, that the hearer is irresistibly infected with all the rage of precipitate courage, notwithstanding the rudeness of the accents by which it is kindled. To this the *pastoral* forms a striking contrast. Its accents are plaintive, yet soothing; its harmony generally flat; its modulations natural and agreeable; its rhythmus simple and regular; its returning cadences at equal distance; its transitions from one concinnous interval to another, at least for the most part; its movements slow, and may be either in common or treble time. It scarcely admits of any other harmony than that of a simple bass. A greater number of parts would cover the air, and destroy the melody. To this we shall add what has been said upon the same subject by Dr Franklin. Writing to Lord K——, he proceeds thus:

“Give me leave on this occasion, to extend a little the sense of your position, ‘That melody and harmony are separately agreeable, and in union delightful,’ and to give it as my opinion, that the reason why the Scotch tunes have lived so long, and will probably live for ever (if they escape being stifled in modern affected ornament) is merely this, that they are really compositions of melody and harmony united, or rather that their melody is harmony. I mean, the simple tunes sung by a single voice. As this will appear paradoxical, I must explain my meaning. In common acceptance, indeed, only an agreeable *succession* of sounds is called *melody*; and only the *coexistence* of agreeable sounds, *harmony*. But since the memory is capable of retaining for some moments a perfect idea of the pitch of a past sound, so as to compare it with the pitch of a succeeding sound, and judge truly of their agreement or disagreement, there may and does arise from thence a sense of harmony between the present and past sounds, equally pleasing with that between two present sounds. Now the construction of the old Scotch tunes is this, that almost every succeeding emphatical note is a third, a fifth, an octave, or in short some note that is in concord with the preceding note. Thirds are chiefly used, which are very pleasing concords. I use the word *emphatical*, to distinguish those notes which have a stress laid on them in singing the tune, from the lighter connecting notes that serve merely, like grammar-articles in common speech, to tack the whole together.

“That we have a most perfect idea of a sound just past, I might appeal to all acquainted with music, who knows how easy it is to repeat a sound in the same pitch with one just heard. In tuning an instrument, a good ear can as easily determine that two strings are in unison by sounding them separately, as by sounding them together; their disagreement is also

as easily, I believe I may find more easily and better distinguished when sounded separately; for when sounded together, though you know by the beating that one is higher than the other, you cannot tell which it is. I have ascribed to memory the ability of comparing the pitch of a present tone with that of one past. But if there should be, as possibly there may be, something in the ear similar to what we find in the eye, that ability would not be entirely owing to memory. Possibly the vibrations given to the auditory nerves by a particular sound may actually continue some time after the cause of these vibrations is past, and the agreement or disagreement of a subsequent sound become by comparison with them more discernible. For the impression made on the visual nerves by a luminous object will continue for 20 or 30 seconds."

After some experiments to prove the permanency of visible impressions, he continues thus :

"Farther, when we consider by whom these ancient tunes were composed, and how they were first performed, we shall see that such harmonical successions of sounds was natural and even necessary in their construction. They were composed by the minstrels of those days, to be played on the harp accompanied by the voice. The harp was strung with wire, which gives a sound of long continuance; and had no contrivance like that of the modern harpsichord, by which the sound of the preceding note could be kept the moment a succeeding note begin. To avoid actual discord, it was therefore necessary that the succeeding emphatic note should be a cord with the preceding, as their sounds must exist at the same time. Hence arose that beauty in those tunes that has so long pleased, and will please for ever, though men scarce know why. That they were originally composed for the harp, and of the most simple kind, I mean a harp without any half-notes but those in the natural scale, and with no more than two octaves of strings, from C to C, I conjecture from another circumstance; which is, that not one of these tunes, really ancient, has a single artificial half-note in it; and that in tunes where it is most convenient for the voice to use the middle notes of the harp, and place the key in F, there the B, which if used should be a B flat, is always omitted, by passing over it with a third. The connoisseurs in modern music will say I have no taste; but I cannot help adding, that I believe our ancestors, in having a good song, distinctly articulated, sung to one of those tunes, and accom-

panied by the harp, felt more real pleasure than is communicated by the generality of modern operas, exclusive of that arising from the scenery and dancing. Most tunes of late composition, not having this natural harmony united with their melody, have recourse to the artificial harmony of a bass, and other accompanying parts. This support, in my opinion, the old tunes do not need, and are rather confuted than aided by it. Whoever has heard *James Oswald* play them on his violincello, will be less inclined to dispute this with me. I have more than once seen tears of pleasure in the eyes of his auditors; and yes, I think, even *his* playing those tunes would please more if he gave them less modern ornament."

As these observations are for the most part true and always ingenious, we need no other apology for quoting them at length. It is only proper to remark, that the transitions in Scots music by consonant intervals, does not seem, as Dr Franklin imagines, to arise from the nature of the instruments upon which they played. It is more than probable, that the ancient British harp was not strung with wire, but with the same materials as the Welsh harps at present. These strings have not the same permanency of tone as metal, so that the sound of a preceding emphatic note must have expired before the subsequent accented note could be introduced. Besides, they who are acquainted with the manœuvre of the Irish harp, know well that there is a method of discontinuing sounds no less easy and effectual than upon the harpsichord. When the performer finds it proper to interrupt a note, he has no more to do but return his finger gently upon the string immediately struck, which effectually stops its vibration.

That species of Scotch music which we have distinguished by the name of *seftive* seems now limited to reels and country-dances. These may be either in common or treble time. They most frequently consist of two strains: each of these contains eight or twelve bars. They are truly rhythmical; but the mirth which they excite seems rather to be inspired by the vivacity of the movement, than either by the force or variety of the melody. They have a manœuvre and expression peculiar to themselves, which it is impossible to describe, and which can only be exhibited by good performers.

Thus far we have pursued the general idea of music. We shall, after the history, give a more particular detail of the science from Monsieur D'Alembert.

## HISTORY OF MUSIC.

<sup>1</sup>  
THE ancient history of music, even among the most cultivated nations, is now either so entirely lost, or so unhappily obscured, that we can make but few certain, and perhaps no satisfactory discoveries in it. And as no annals could be transmitted to posterity of that music which prevailed among such people as are called *barbarous*, our accounts of it must be still less authentic and satisfactory, than those of the former. Even at periods which are more recent, and may for that reason be thought more within the sphere of our investigation, we are equally at a loss both for the *eras* and the authors of some

essential improvements in music. Yet those parts of its history, which are either already known, or may be discovered, if related at full length with proper illustrations, would produce a work little inferior in size to the whole extent of that *Encyclopædia* of which it only constitutes a part. All, therefore, which can be expected from this preliminary account, is to give a short and cursory detail of its primary state, and its most important revolutions, so far as history will enable us, by enlightening our researches, to accomplish this design. But if our accounts are thought concise and imperfect, we shall all along direct

<sup>1</sup>  
The uncertainty of facts in musical history whether ancient or modern.

direct the views of our readers to sources which may prove more copious and more adequate to their curiosity.

It has been pretended by Father Kircher and others, that music prevailed in Egypt before it was known in Greece. These authors derive its name from a word which is primitive in the Egyptian language, and attribute the invention of the art to the frigidulous murmur of the winds whistling through reeds, or other vegetable tubes, which grew upon the banks of the river Nile. But if this idle and legendary account of the discovery merits any attention at all, it must relate to instrumental music alone: for it cannot be imagined that mankind, if in the least degree attentive to the natural modulation of their own voices, and to such transitions of sound as were agreeable or disagreeable, would have recourse for their ideas of melody to objects so extrinsic and so contingent as the whistling of winds through a reed. Man is certainly as much a musical as he is a vocal animal; nor is the act of singing in him less instinctive than in birds, though his powers are more extensive and more susceptible of culture than theirs. If we believe the accounts of such as have been attentive to the music of the groves, they will tell us, that though the feathered warblers have a musical instinct, yet the modes of its exertion are as really acquired by birds from their parents or tutors as by men\*. Nor is it easy to conceive a human creature, endowed with the natural powers of musical sensation, and advanced to any degree of maturity, without supposing at the same time that he has tried several musical experiments, and that in some degree he has formed and cultivated his natural organs. At the same time, it cannot be denied, that the degrees of sound, passing through tubes of different textures, lengths, and diameters, or of strings whose magnitudes and degrees of cohesion were different, must be ascertained by experiment alone. But whether these experiments were the result of contingency or design, whether observation took the hint from nature, or began of itself to make trials and preserve their results, it seems now too late to determine.

The origin of instrumental music appears to have been at a period much prior to the date of authentic history; and when we look for its epoch or its discoverer, we are carried at once into the wild regions of fable and mythology. The god Mercury, or Hermes, is said to be the inventor of the lyre\*, by distending strings of different tensions and diameters upon the shell of a tortoise which he found upon the shore. The first exhibition of the fiddle, or shepherd's pipe, is ascribed to Pan. But of these beings and their actions, little or nothing can be ascertained with proper evidence †. We must therefore content ourselves with such later accounts as merit any degree of confidence.

The Grecian lyre, in its original state, seems to have been an instrument of the utmost simplicity: for, according to some, the Mercurian lyre consisted only of three, and according to others only of four, strings. These being touched open, could only produce the same number of sounds: from whence we may easily conclude, that the powers of this instrument could not be very extensive. This tetrachord, as some say, was conjoined; others maintain that it was disjoined, and

that its intervals were not even diatonic. It is, however, allowed, that its two extremes produced an octave; and that the two intermediate strings divided it by a fourth on each side, with a tone in the middle, in the following manner:

Ut, ———— Trite diezeugménon.  
Sol, ———— Lichanos méton.  
Fa, ———— Parhypate méton.  
Ut, ———— Parhypate hypaton.

This is what Boëtius calls the tetrachord of Mercury; though Diodorus asserts, that the lyre of Mercury had only three strings. This *system* did not long remain confined to so small a number of sounds. Chorea, the son of Athis king of Lydia, added to it a fifth string; Hyagnis, a sixth; Terpander, a seventh, to equal the number of the planets; and at last, Lychaon of Samos the eighth.

This is the account of Boëtius. But Pliny says, that Terpander having added three strings to the four which were original, first played upon the cithara with seven strings: that Simonides joined to them an eighth, and Timotheus a ninth. Nicomachus the Geralesian attributes this eighth chord to Pythagoras, the ninth to Theophrastus of Piereus, afterwards the tenth to Hyfteus of Colophon. Pherecratus, in the dialogue of Plutarch, makes the *system* advance with a more rapid progress: he gives twelve strings to the cythara of Menalippides, and as many to that of Timotheus. And as Pherecratus was contemporary with these musicians, if we suppose that he really said what Plutarch attributes to him, his testimony will have considerable importance in a fact which was obvious to his own immediate observation.

But how shall we obtain any certainty among such a number of contradictions as are found not only in the doctrines of the authors, but in the order of the events which they relate? For instance, the tetrachord of Mercury evidently gives the octave or diapason. How then could it happen, that, after the addition of three strings, the whole scale was found to be diminished by one degree, and reduced to the interval of a seventh? This is, however, what the greatest number of authors leave us to understand; and among others Nicomachus, who tells us, that Pythagoras, finding the whole *system* composed only of two conjoined tetrachords, which between their extremes formed a dissonant interval, rendered it a consonance, by dividing these two tetrachords by the interval of a tone, which produced the octave.

Whatever be the case, there is at least one thing certain, that the system of the Greeks was insensibly extended as well above as below, till it reached, and even surpassed, the compass of a didiapason or double octave; a series which they call a *perfect system*, and which was likewise termed the *greatest* and the *most unchangeable*; because, between its two extremes, which betwixt themselves formed a perfect consonance, were contained all the simple, the double, the direct, or the inverted chords, every particular system, and according to them the greatest intervals, which can take place in melody.

This whole system consisted of four tetrachords, three conjoined and one disjoined; and of a single of the peritone redundant, which was added below the whole to complete the double octave; from whence the string

2  
Opinions concerning the origin of music.

\* See the article SINGING of Birds.

3  
Origin of instrumental music.

\* See the article LYRE.

† See the articles HERMES and MERCURY.

4  
The Grecian lyre in its original state a simple instrument.

5  
The scale extended.

6  
Ancient authors on music inconciliable.

7  
The nature of a single of the peritone.

which formed it took the name of *proslambanomenes*, or the additional string. This, one would imagine, could only form fifteen notes in the diatonic genus; there were, however, sixteen. This was because the disjunction being sometimes perceived between the second and third tetrachord, and at other times between the third and fourth, it happened, in the first case, that the found *la* or *A*, the highest in the second tetrachord, the *fi* or *B* natural, with which the third tetrachord began, immediately followed in ascending; or otherwise, in the second case, that the same found *la*, with which note itself the third tetrachord began, was immediately followed by *fi* or *B* flat; for the first gradation of every tetrachord, in the diatonic species, consisted always of a semitone. This difference then produced a sixteenth found, on account of the *fi* or *B*, which was natural or flat according to its various positions in the different tetrachords. The sixteen founds were expressed by eighteen different names; that is to say, that *ut* or *C*, and *re* or *D*, being either the sharpest or the middle founds of the third tetrachord, according to the two manners of disjoining the tetrachords, they gave to each of these two founds a name which determined its position.

But as the fundamental found was varied according to the mode, from the situation occupied by each mode in the general system arose a difference of acuteness and gravity, which very much multiplied the founds: for though the different modes had many founds in common, there were likewise some peculiar to each mode, or to some of them alone. Thus, in the diatonic genus alone, the extent of all the founds admitted in the fifteen modes enumerated by Aliphius amounted to three octaves; and as the difference between the fundamental found of each mode and that of its contiguous found was a semitone only, it is evident, that all that space divided by semitones produced, in the general scale, the quantity of thirty-four founds practised in ancient music; which, if we deduct all the replicates of the same found, and confine ourselves to the limits of an octave, it will be found to be chromatically divisible into twelve different founds, as in modern music. This is obvious from the table placed by Meibomius at the front of Aliphius's work. These remarks are necessary to refute the error of those who believe, upon the credit of some moderns, that the whole of ancient music was limited to sixteen founds.

In Rousseau's Musical Dictionary, Plate H, fig. 12. will be found a table of the general system amongst the Greeks, taken in one mode only, and according to the diatonic genus. With respect to the enharmonic and chromatic genera, the tetrachords were divided by very different proportions; but as they always contained four founds and three consecutive intervals, in the same manner as the diatonic genus, each of these founds, in its particular genus, bore the same names which corresponded with them in the diatonic. For this reason Rousseau, whom we follow, has not given particular tables for each of these genera. The curious may consult those of Meibomius, placed at the front of the work of Arrioxenus. They will there find six; one for the enharmonic genus, three for the chromatic, and two for the diatonic, according to the situations of each of these genera in the system of Arrioxenus.

Such, in its perfection, was the general system of the Greeks; which remained almost in the same state till the eleventh century, the time when Guy d'Arezzo made considerable changes in it. He added below a new string, which he called *hypoproslambanomenes*, or "sub-added," and above a fifth tetrachord. Besides this, he invented, as they say, a flat, to distinguish the second found of a conjunctive tetrachord from the first of the same tetrachord when disjunctive; that is to say, he fixed the double signification of the letter *B*, which St Gregory before him had already given to the note *fi* or *B*. For since it is certain that the Greeks had for a long time these very conjunctions and disjunctions of the tetrachord, and of consequence signs for expressing each degree in these different cases, it follows, that this was not a new found introduced into the system of Guido, but merely a new name which he gave to that found; thus reducing to one degree what, among the Greeks, had constituted two. It must likewise be observed concerning his hexachords, which were substituted for their tetrachords, that it was less a change of system than of method; and that all which resulted from it was another manner of solving the same founds. But the character of Guido, and the alterations which he made in the ancient scale, may be more properly resumed [when we reach the period in which he lived. We have already seen from Rousseau, that the different accounts of the system and its improvements, of the different kinds of music, and of the modes to be met with among ancient harmonists, are so various and so obscure, that, in these disquisitions, little or no satisfaction can be obtained. For ascertaining with accuracy the diversity of intervals, Pythagoras, the philosopher of Samos, invented the monochord, or the different divisions of one single string by which the consonances were produced, and found the same ratios which are given in the subsequent elements of music, in Malcolm's account of the scale, and in several other authors unnecessary to be enumerated. For a fuller and more exact account of this monochord, and its use, see the History of Music by Sir John Hawkins, Vol. I. p. 449. where the necessity of applying it to practice is inculcated by Guido.

Had succeeding writers upon the science been more attentive to the real constitution of the scale, and the principles derived from a monochord properly divided, we might have expected their account of the other phenomena in music to have been more precise and more perspicuous; but for a considerable time after that philosopher, the accounts of ancient music transmitted to us are either superficial and cursory, or unintelligible. The modes, of which Aliphius reckoned fifteen, are by Ptolemy limited to seven. Even of the seven Ptolemaic modes, it would seem that five must be merely possible and nominal; two only real and practical. These appear to coincide with the major and minor mode of the moderns, by which effects similar to those ascribed to the ancient modes are produced. Still, however, this hypothesis is attended with some difficulty: The effects attributed to the modes of the moderns seem to be no more than cheerfulness and melancholy; whereas it would appear that different sentiments were thought to be naturally excited by all the different modes of the ancients, such as courage and terror, fury and complacency, &c. Yet

8  
The Grecian scale changed that which is now in use by Guido Arezzo

9  
The invention and use of the monochord

10  
Diversity of opinions concerning modes.

Yet if by ancient modes we are to understand any given intervals which predominate in a piece of music, it is far from being easy to conceive any other explanation which will so rationally account for the modes of Ptolemy, as that which we have immediately before recited. A more particular detail of this author, of Boetius, and of Aristides Quintilianus, than it is in our power to give, circumscribed as we are by limits much too narrow for such an undertaking, will be found in Sir John Hawkins's History of Music, Vol. I. These are some of the chief writers whose works remain to us, and have escaped the deprivations of time. Most of the other ancient writers upon music either appear to have been lost, or only to have treated the subject occasionally. Among these may be reckoned Vitruvius, author of a treatise on architecture, who, in his description of theatres, takes the opportunity of proposing some musical improvements, of making some casual observations upon the art, and of describing an hydraulic organ. But as a more particular account of these would throw no additional light upon the theory of ancient music, for this we must once more remit the curious to *Meibomius de re Musica*, and to the history by Sir John Hawkins above quoted.

The province to which our efforts are necessarily confined, directs our attention not so much to the history of those who cultivated the art, as to the art itself, and its various revolutions.

The discovery of the monochord and its divisions, was not the only speculation in music peculiar to Pythagoras. He likewise thought the earth and seven planets, or solar system, resembled a musical diapason; and from thence formed the romantic idea of the music of the spheres. For a more satisfactory account of this celestial concert, the curious reader may peruse the *Somnium Scipionis*, a fragment of Cicero, and the *Observations upon numbers* by his commentator Macrobius.

Pythagoras, the philosopher of Samos, as we have said above, who taught in Italy, was the first who investigated the relations of sound by measuring a musical string, and observing the tones produced by the vibrations of its different parts, whilst the others were at rest. These he expressed by numbers, and thus ascertained the ratio which one found bears to another. This investigation was afterwards carried farther, and delineated more distinctly, by Euclid; and gave rise to a controversy which divided the theoretical writers on ancient music into two principal sects, viz. the followers of Pythagoras, who maintained that intervals could only be ascertained by the vibrations of sonorous bodies compared one with another; and those of Aristoxenus, who asserted the judgment of the ear to be the ultimate criterion of intervals. Perhaps neither were absolutely right, nor entirely wrong. Without ascertaining by experiments and calculations the distances of tones, or quantities of intervals, we can by no means obtain the same certainty of their exactitude, whether in tuning instruments of fixed scales, or in performing upon those whose notes admit of variation, and where the temperament is immediate and occasional. So far the Pythagoreans are right. Yet the Aristoxenians might likewise urge, that though we could suppose a being acquainted with all the properties, relations,

and modes of quantity, in their full extent; if such a one, with all this knowledge, should attempt from mere theory to compose a piece of good music, he might be eternally engaged in the same employment to no purpose, and have the mortification to see himself every instant outdone by a mere mechanical performer, who had been long inured to judge of intervals, and practised in the laws of harmony. In short, the whole powers of geometry and algebra may be exhausted, without producing a musical strain which will give real pleasure to the ear. An adept, therefore, in this delightful art, will regulate his practice by his theory, and confirm his theory by his practice. He will not imagine the necessity of experiment and calculation superadded by the decision of his ear; nor will he endeavour to extort from the abstract nature of numbers (which are equally applicable to all subjects that contain quantity) those rules which taste and sensation alone can suggest, and of which they are the ultimate standard.

Nicomachus the Geranienus lived A. C. 60, and wrote a book called *Introduction to harmony*, which seems to be one of the clearest and most intelligible of the Greeks.

In the *Symposiaca* of Plutarch is a dialogue on music, containing many anecdotes with respect to the invention of several different species of music and poetry. There Phrynis and Timotheus are recorded to have been stigmatized for adding what were esteemed superfluous strings to the lyre, which at that time had only seven, to mark the different degrees of the diapason. But the additional strings were tuned by intervals less than diatonic. This dialogue, however, is acknowledged to be obscure, and its authenticity questioned.

After exploring what can be known concerning the ancient music, from the theories and writings of those whose works have been transmitted to us, the forms and powers of their instruments occur next to be examined. These can only be collected from verbal descriptions, or from designs either expressed in colours or by sculpture. From these, modern musicians have not scrupled to form a most contemptible idea of practical music among the ancients. But are we sure, that the descriptions are perfectly complete and thoroughly understood? If they were, does there not still remain a possibility, that they might be tuned and handled in a manner productive of effects to which we are strangers? Of our instruments now in use, the difference between one manner of performing and another is so astonishing, that one should imagine it might render us cautious in forming any conclusions concerning instruments, which are perhaps neither perfectly described nor exactly delineated, described by authors of a period sufficiently distant to render the idioms of the language in which they wrote obscure. And tho' the forms exhibited in colours or by sculpture may be thought more permanent and more universally intelligible, they are yet sufficiently subjected to the injuries of time to render their representations suspicious. It cannot be doubted, but that the accounts of the ancients, of the power and efficacy of their music, were frequently fabulous and hyperbolic; but still they are such as, when divested of these accidental circumstances, must convince any man of common sense, who admits

11  
The application of numbers to musical intervals divides musicians into different sects.

12  
The principles of these sects estimated.

13  
The forms and powers of ancient instruments

14  
The power of ancient music, tho' exaggerated in some parts, must have been great to give them the fables credited

the evidence of history, that they are superior to what we at present experience in music with all its boasted improvements. It may well be admitted, that the miracles ascribed to Orpheus and Amphion are false in their literal sense; but no person will imagine, that, even among the superstitious and illiterate vulgar, fables of this kind could have obtained any degree of attention, or been entertained with any other sentiments than those of ridicule, if the truths which they adumbrated had not been uncommonly striking. Nor would it have been relished as a tolerable legend, that music had the power of animating stones and trees, if its visible effects upon sensitive beings at that period had not been wonderfully transporting. It is therefore a degree of incredulity which does no great honour to the authority of modern testimony, to doubt the assertion of Horace, when he tells us, that, by the force of music, the human savage was allured from his acorns, his brutal pastimes, and his sanguine broils, to the more decent habits and amiable employments of social life. It has been formerly observed, that among such nations as were esteemed barbarous, we meet with no accounts either of music or its instruments which either deserve credit or attention. It is not easy to conceive how the Jews, who had made such a great progress in arts and civilization, should still have remained so backward in their musical acquisitions, as they must have been if we take for granted the figures and powers of their instruments, as delineated by Kircher, and transcribed by Sir John Hawkins. Nor will the advantages which are generally allowed to the instruments of other barbarous nations, afford a satisfactory account how they were able either to compose or perform such pieces of music as we know them to have possessed. We must therefore with good reason suspect, that the authors of such descriptions have either been grossly ignorant of the subject, or shamefully careless and remiss in the performance of their task.

Almost in every period since the restitution of literature, an important controversy has been agitated by virtuosi of different opinions in the theory of music. Some have maintained that harmony was, and others that it was not, known to the ancients. By some of these it was contended, that the knowledge of harmony naturally results from the knowledge of consonances; that by tuning their instruments the ancients must have been familiar to the various coalescences of sound, and that of consequence they could not be ignorant of the pleasure which they produce. Several passages likewise from such dissertations or fragments as have escaped the rage of time, are collected to prove that the ancients must have been acquainted with harmony or symphonical music.

The opponents of this hypothesis have alleged, that from the sensations or ideas of simple chords no conception could be formed of the effects produced by their conjunction or succession. It is on all hands agreed, that several voices and instruments were used by the Greeks and Romans in performing the same piece of music; but the antiharmonists, as we may term them, will not admit that the intervals of these voices or instruments were varied: nay, it is affirmed that they performed always in octave or unison one to the other; and from thence it is pretended,

that all the passages which seem to import the acquaintance of the ancients with practical harmony may be rationally and confidently explained. This, however, notwithstanding the labours of French critics, will still remain extremely doubtful to any person who has either perused the dialogue above mentioned as ascribed to Plutarch, or other passages to the same purpose. Nor can it be reasonably thought, that, at a period so barbarous as the 12th century, harmony, though rude and simple, should have been the creature of naked invention in places where every other branch of literature and degree of culture were unknown. Yet it is clear from the monkish historians of that æra, that harmony was even then in practice, where it could hardly be supposed to be immediately transmitted by a progress so rapid from other parts of the world, where the finer organization of the natives, the more propitious aspect of nature, and the more obvious vestiges of ancient improvement, might be thought favourable to the invention, culture, and propagation of the fine arts. Nor is it a weak presumption, in favour of the knowledge of antiquity in harmony, that the adherence of a contrary opinion can neither ascertain the epoch nor the parent of symphonical music. Yet had it been, as they pretend, a modern invention, barbarous and ignorant as the general character of human nature was during that gloomy interval from the decline of the Roman empire to the resuscitation of letters, the author of an improvement so new and extraordinary could not have escaped the public notice. His name, his character, and his discoveries, must have been recorded by the cloistered authors of his time with panegyric and admiration. We cannot therefore cease to think with the author of *The principles and power of harmony*, p. 133, that the ancients were better acquainted with this species of music than the moderns. They are willing to allow; though perhaps it may be admitted, that its powers were neither so thoroughly known, nor so generally and successfully practiced, as afterwards.

After the long and cruel devastation of the Goths and Vandals, music seems first to have been revived for the service of the church. It was then of two different kinds, one of which was called the *Ambrosian* and the other the *Gregorian* chant. Of these, the last prevailed, and became universal, till corrupted by the ignorance or false taste of its teachers and performers. This degeneracy became at last the subject of high remonstrance and complaint. It seems to have consisted in a total negligence of rhythmus, and in a perversion of that licence of gracing the notes, which is so essential to all emphatic and animated music. It became, however, so contagious and diffusive, that monarchs thought the rescue of the *Cantus Gregorianus* an object worthy of their interposition. They accordingly authorized more profound adepts and more accurate performers to teach and practise it in its purity through their several dominions. The *antiphonaries*, or books of ecclesiastical music, were rectified, and a more correct and legitimate taste re-established. Thus the *Cantus Gregorianus* once more triumphed over ignorance and barbarity, and obtained a reception worthy of its original sublimity. It is denominated among the French, and by Rousseau in particular, *plain chant*. That author scruples not to reckon

15  
The music of barbarous nations covered with obscurity.

16  
Harmony, whether known to the ancients or not, uncertain.

17  
Origin of author of harmony doubtful

18  
This is a supplement to the antiquity of harmony.

19  
Revival of music.

it a precious remain of antiquity. For a short account of the nature and revolutions of this music, may be consulted the article *Plain Chant* in his Musical Dictionary. From whence it appears, that the Gregorian music was not originally different from the Ambrosian, but the latter only an improvement upon the former. One would be tempted to suspect, that the first gradation of this music towards its decline was occasioned by transferring it from verse to prose. In consequence of which, that strict and inviolable regard to measured sounds, so conspicuous in ancient music, and so effectually preferred by the aptitude of measured notes to measured syllables, was lost. There is, we know, even in profaic compositions, a rhythmus. The Roman orators were accustomed to scan their sentences in prose. But though even periods of this kind were by no means emancipated from the laws of rhythmus, yet were they much more loose and indefinite than poetical numbers, which were constituted by feet and syllables whose quantities were determined. From thence, and from the cadences by which they are marked, alone, can result that regularity and satisfaction in which the musical ear acquiesces, and without which every thing is unintelligible. It was this religious observation of determined and regular quantities in ancient poetry, which preserved and regulated the due proportion of sounds, and which, when abandoned, left the value of notes, with respect to their duration, impossible to be determined, till other characters and signs were superadded, which discovered the real estimate of every note, and showed to what degree it should be protracted, or by what quantity of duration limited. This seems to have been the next advance in musical improvement; but it had one pernicious effect, which was, to render music independent of poetry. Yet these sister-arts seem to be twin-born from heaven; and perhaps, in no case could the laws of nature have suffered a more cruel and impious violation than in separating the one from the other. Modulated sound is a more genuine, powerful, and universal vehicle of sentiment, than any articulate or arbitrary signs can possibly be. But articulate signs may be so happily adjusted by convention, as to express degrees, varieties, and modes of sentiment or emotion, which in modulated sounds are less definitely signified, if signified at all. Thus sounds give energy and sweetness to word, words variety and definiteness to sounds.

We have already observed, that Guy d'Arezzo, otherwise named *Guido Aretinus* †, was the inventor of that disposition of the musical scale which is now in use. He could not, therefore, be the author of harmony, which we know to have been practised some centuries before his time, but only of a new set of characters by which it was expressed. This musician, by changing the tetrachords into hexachords, highly improved the scale, discovered more accurately the position of semitones, and rendered its intonation much more practicable. He likewise adapted the syllables *ut, re, mi, fa, sol, la*, to the various sounds which compose it, from the following Sapphic verses in a hymn to St John.

UT *queant laxis*      RESonare *fibris*  
 MIRA *gestorum*      FAnuli *tuorum*  
 SOLve *polluti*      LABii *reatum*.

SANCTE JOANNES.

The rhythmus in music, or the regular division and measures of sound, had formerly been determined by the quantities of the feet in poetry; and, independent of these, seems to have been entirely indefinite. The invention of a rhythmus capable of subsisting by itself, is ascribed to one *Johannes de Muris*. Yet there is considerable reason to believe that it had been invented by one *Franco*, who lived a number of years before him.

In these times there was a secular as well as a sacred music. The Troubadours, or Provençal poets, composed songs of different kinds, which they sung on their harps or violins for public entertainment. Hence it happened, that harmony, melody, and rhythmus, admitted of immensely greater varieties than they had hitherto done. We have formerly said, that in ancient music, the quantities or values of every note were determined by those of the syllables to which they answered. It is, however, by no means improbable, that at a very early period, in their private rehearsals, or practice for improvement, whether in taste or execution, the musicians frequently played the instrumental parts without being accompanied either by the voice or the words to which they had been set. The impressions of those poetical measures to which the parts corresponded, were abundantly sufficient to preserve in the memory of the performer the idea of the rhythmus, and of course to determine the value of each particular note. But when airs were either set to pieces in prose, or composed without any regard to syllabic duration, the quantity of each note was absolutely indefinite. When therefore music begun to be set in parts, it was indispensably necessary that the points which mark the notes intended to correspond one with another, should be set in direct opposition. Hence the denomination of *counterpoint*. But when characters, or different forms of characters, were invented for expressing the different durations of sounds, or their relative proportions one to another, the same precision in opposing note to note became less necessary, and was on that account less scrupulously observed. It might, perhaps, be neither an unpleasing nor uninstrucive deduction, after having delineated the nature of simple counterpoint, to trace it thro' all its different species or divisions; but the contracted sphere in which we are at present constrained to move, obliges us to confine these excursions. Such readers as may wish more profoundly and minutely to examine this matter, will find it more perspicuously and fully explained in Sir John Hawkins's History. To this they may likewise recur for an idea of the characters or methods by which the precise duration of particular notes might be ascertained. For us, it suffices to add, that the method now in practice, which are explained in the following elements, will be found more simple, whilst at the same time, it is equally expressive and intelligible.

The airs into which secular music was originally distinguished seem to have been the madrigal, the song, secular music, the cantata, the canon. These were vocal, or at least common to voices and instruments; but the solo, the phantasia, the concerto, were progressive changes in instrumental music. By what gradations they proceeded, and who were the inventors of each particular species, we cannot attempt to show, not only because such a disquisition would be incompatible with

[ b ]

the

<sup>20</sup> Inventions of characters to express the rhythmus.

<sup>21</sup> Affinity between music and poetry.

† See the article ARETIN.

<sup>22</sup> Division of music into ecclesiastical and secular.

<sup>23</sup> Origin of the term counterpoint.

<sup>24</sup> Division of music into secular and sacred.

the limits of our plan, but because we should find it frequently impracticable either to investigate the hints from which such innovations arose, or the persons by whom they were made.

If music be allowed to possess imitative powers, it will follow, that in proportion as the objects are interesting, the imitation must likewise engage and command attention. From this, it will be acknowledged, that as imitation is the chief purpose of dramatic music; as the actions, characters, and situations exhibited in the drama, are the most interesting that can possibly be displayed; and as the dramatic is allowed to be the most perfect of all possible imitations; so of all music, the dramatic, in its perfection, ought to be the most powerful and enchanting. It is therefore a research of no small importance, to discover when this kind of music was first revived, and by what degrees it arrived at its present state.

It is generally agreed, that the Greeks and Romans sung their tragedies and comedies from beginning to end; but no monument of these compositions remains to us: so that the music of the drama is as really a modern invention as if no such thing had subsisted among the ancients, since the mere knowledge of a fact could by no means throw any light upon the manner in which it was produced. All that has been transmitted to us concerning the ancient theatrical music, can only inform us, that it was pathetic and imitative to a high degree. But upon these hints few composers will think themselves sufficiently instructed to proceed. This arduous enterprise, however, was nobly begun and successfully prosecuted by one *Yacopo Peri*. A poet, whose name was *Ottavio Rinuccino* in the city of Florence, having composed a dramatic pastoral upon the story of Apollo and Daphne, engaged this excellent musician to set it. Both being warmed with the same ideas, and animated by the same design, so happily succeeded, that other poets and musicians were generally approved and admired in proportion as they pursued the vestiges of these great masters. A second performance of the same kind, called *Eurydice*, composed by the authors of the former pastoral, was represented in Florence in the year 1600, upon occasion of the marriage of Mary de Medicis with Henry IV of France. But a detail of the gradations by which theatrical music rose to its present perfection, would be a task too extensive for the limits by which we are circumscribed. Nor is it in our power, for the same reason, to enter more minutely and critically into the nature of those compositions called *operas*. Let

it suffice to add, that, in common with tragedy and comedy, they are representations of action. In consequence of this, they require the same unity of design, the same diversity of characters and passions, with the former. Hence it follows, that some parts of them will be simply narrative, some pathetic, and others more emphatically descriptive. Music suited to the first of these is called *recitativo*. Its distinguishing characteristics are, to express the nature and degree of sentiment exhibited by the speaker, to be scrupulously adapted to the peculiar genius of that language which it is designed to accompany; and to be exactly modelled according to the accents of that nation, for which it was formed. Some authors have pretended that the irresistible efficacy of melody was founded upon this principle alone. But if that position be true, in what

manner shall we account for the wonderful influence of an Italian recitativo upon a British audience, and for other phenomena of the same kind too numerous to be mentioned? Such parts of the music as are intended for more pathetic declamations may be called *airs*. In these the words, both with respect to their quantity and order, may be treated with greater freedom. The melody is less in the tone of conversation, and the harmony more complex. In this, however, there is no small hazard lest sentiment should be lost in found; and it requires no small degree of judgment, delicacy, and taste in the composer, at once to fill the harmony and preserve the sentiment. But of this the reader will find a more complete account under the article AIR in this Dictionary. The chorus is intended to express some emphatic event, to celebrate some distinguished hero, or to praise some beneficent god. It is properly the voice of triumph and exultation. The harmony should therefore be as full and expressive as possible. But for the rules of such compositions, one must refer the reader to such theoretical and practical musicians as have been most successful in describing and cultivating dramatic music. What remains for us is to subjoin a list of those who have been most remarkable for their accuracy in the theory, or for their excellence in the practice, of music in general.

Of John de Muris we have already spoken, who lived in the year 1330, and to whom, by mistake, has been attributed the invention of those characters by which, in modern times, the value of notes, and their relative proportions one to another, have been ascertained. But this expedient for making visible the different durations of notes as constituent of one rhythm or particular movement, we have found to be first introduced by one Franco, who lived prior to John de Muris.

Lafus was the first who wrote on music; but his work is lost, as well as several other books of the Greeks and Romans upon the same subject. Aristoxenus, the disciple of Aristotle, and leader of a sect in music, is the most ancient author who remains to us upon this science. After him came Euclid of Alexandria. Arithmidis Quintilianus wrote after Cicero. Alyphus afterwards succeeded; then Guadentius, Nicomachus, and Bacchius.

Marcus Meibomius has favoured us with a beautiful edition of these seven Greek authors, with a Latin translation and notes.

Plutarch, as has already been said, wrote a dialogue upon music. Ptolemy, a celebrated mathematician, wrote in Greek a treatise intitled *The Principles of Harmony*, about the time of the emperor Antoninus. This author endeavoured to preserve a medium between the Pythagoreans and the Aristoxenians. A long time afterwards, Manuel Prynennius wrote likewise upon the same subject.

Among the Latins, Boetius wrote in the times of Theodoric; and not distant from the same period Martinianus, Cassiodorus, and St Augustine.

The number of the moderns is almost indefinite. The most distinguished are, Zarlino, Salinas\*, Valgulio, Galileo, Doni, Kircher, Merenne, Parran, Pe-rault, Wallis, Descartes, Holden, Mengoli, Malcolm, Baretti, Vallotti, Marcus Meibomius, Christopher Simpson; Tartini, whose book is full of deep researches

and

25  
Revival of  
dramatic  
music.

26  
Delineation  
of the opera.  
38.

27  
Catalogue  
of theatri-  
cal and  
practical  
musicians.

\* See the  
BLIND.



and of genius, but tedious from its prodigious length, and perplexed with obscurity; and M. Rameau, whose writings have had this singular good luck, to have produced a great fortune without being read almost by any one. Besides, the world may now be spared the pains of perusing them, since M. d'Alembert has taken the trouble of explaining to the public the system of the fundamental bass, the only useful and intelligible discovery which we find in Rameau's writings. To these we may add Dr Smith, author of a learned and mathematical treatise, intitled, *Harmonics*, or *The Philosophy of musical Sounds*; Mr Stillingfleet, author of the *Principles and the Power of Harmony*, or *An explication of Tartini's system*; Dr Pepusch, and his noble pupil the Lord Abercorn; Mr Avilon, late organist at Newcastle, who wrote a treatise on *Musical Expression* with the politeness and elegance of a gentleman, the depth and precision of a scholar, the spirit and energy

of a genius. The names of Rousseau and d'Alembert have been so often repeated during the course of these musical lucubrations, that it would be superfluous to resume their characters in this place. Among the authors already mentioned, it would be unpardonable to omit the names of Sir John Hawkins and Dr Burney, each of whom has favoured the world with a history of music: The first protracted to five volumes in quarto, replete with musical erudition, but seldom original; frequently careless, and sometimes too circumstantial and inelegant to be entertaining. Of the last the world has only as yet seen one volume. This abounds with descriptions, events, and disquisitions, highly worthy of attention: but, on account of the limits which the author has prescribed to himself, many things have been omitted which would have been equally acceptable to literary curiosity, and explicative of musical science.

## ELEMENTS OF MUSIC,

### THEORETICAL and PRACTICAL (†).

#### PRELIMINARY DISCOURSE.

28 Musicians considered in a double view.  
 MUSIC may be considered, either as an art, which has for its object one of the greatest pleasures of which our senses (†) are susceptible; or as a science, by which that art is reduced to principles. This is the double view in which we mean to treat of music in this work.

29 Progress of music like that of other arts and sciences.  
 It has been the case with music as with all the other arts invented by men; some facts were at first discovered by accident; soon afterwards reflection and observation investigated others; and from these facts, properly disposed and united, philosophers were not slow in forming a body of science, which afterwards increased by degrees.

The first theories of music were perhaps as ancient as the earliest age which we know to have been distin-

guished by philosophy, even as the age of Pythagoras; nor does history leave us any room to doubt, that from the period when that philosopher taught, the ancients cultivated music, both as an art and as a science, with great assiduity. But there remains to us much uncertainty concerning the degree of perfection to which they brought it. Almost every question which has been proposed with respect to the music of the ancients has divided the learned; and may probably still continue to divide them, for want of monuments sufficient in their number, and incontestable in their nature, from whence we might be enabled to exhibit testimonies and discoveries instead of suppositions and conjectures. As we cannot throw any new light upon this subject, all that can be done is to refer our readers to the different authors who have treated of ancient music. It were to be wished, that, in order to elucidate as much

[ b z ]

(†) To deliver the elementary principles of music, theoretical and practical, in a manner which may prove at once entertaining and instructive, without protracting this article much beyond the limits prescribed in our plan, appears to us no easy task. We therefore hesitated for some time, whether to try our own strength, or to follow some eminent author on the same subject. Of these the last seemed preferable. Amongst these authors, none appeared to us so eligible as the treatise of M. D'Alembert, being the most methodical, perspicuous, concise, and elegant dissertation which we have met with. As this work is hitherto unknown to English readers, it ought to have all the merit of an original. We have given a faithful translation of it; but in the notes, several remarks are added, and many authors quoted, which will not be found in the original. It is a work so systematically composed, that all attempts to abridge it, without rendering it obscure and imperfect, would be impracticable. It is perhaps impossible to render the system of music intelligible in a work of less compass than that with which our readers are now presented; and, in our judgment, a performance of this kind, which is written in such a manner as not to be generally understood, were much better suppressed.

(‡) In this passage, and in the definitions of melody and harmony, our author seems to have adopted the vulgar error, that the pleasure of music terminates in corporeal sense. He would have pronounced it absurd to assert the same thing of painting. Yet if the former be no more than a mere pleasure of corporeal sense, the latter must likewise be ranked in the same predicament. We acknowledge that corporeal sense is the vehicle of sound; but it is plain from our immediate feelings, that the results of sound arranged according to the principles of melody, or combined and disposed according to the laws of harmony, are the objects of a reflex or internal sense.

For a more satisfactory discussion of this matter, the reader may consult that elegant and judicious treatise on *Musical Expression* by Mr Avilon. In the mean time it may be necessary to add, that, in order to shun the appearance of affectation, we shall use the ordinary terms by which musical sensations, or the mediums by which they are conveyed, are generally denominated.

Prelim.  
Discourf.

as poffible, a point fo momentous in the hiftory of the fciences, fome perfon of learning, equally fkill'd in the Greek language and in mufic, fhould exert himfelf to unite and difcufs in the fame work the moft probable opinions eftablifh'd or propof'd by the learned upon a fubject fo difficult and curious. This philofophical hiftory of ancient mufic is a work which might highly embellifh the literature of our times.

In the mean time, till an author can be found, fufficiently intructed in the arts and in hiftory, to undertake fuch a labour with fuccels, we fhall content ourfelves with confidering the prefent ftate of mufic, and limit our endeavours to the explication of thofe acceffions which have accrued to the theory of mufic in thefe latter times.

\* See Melody.  
† See Harmony.  
many.

There are two departments in mufic, melody\* and harmony†. Melody is the art of arranging feveral founds in fucceffion one to another in a manner agreeable to the ear; harmony is the art of pleafing that organ by the union of feveral founds which are heard at one and the fame time. Melody has been known and felt through all ages: perhaps the fame cannot be affirmed of harmony (§), we know not whether the ancients made any ufe of it or not, nor at what period it began to be praftic'd.

Not but that the ancients certainly employ'd in their mufic thofe chords which were moft perfect & fimple; fuch as the octave, the fifth, and the third: but it feems doubtful, whether they knew any of the other confonances or not, or even whether in praftice they could deduce the fame advantages from the fimple chords which were known to them, that have afterwards accrued from experience and combinations.

If that harmony which we now praftice owes its origin to the experience and reflection of the moderns, there is the higheft probability, that the firft effays of this art, as of all the others, were feeble, and the progrefs of its efforts almoft imperceptible; and that, in the courfe of time, improving by fmall gradations, the fucceffive labours of feveral geniufes have elevated it to that degree of perfection in which at prefent we find it.

<sup>31</sup>  
The origin of arts of ten accidental, and their progrefs gradual.

The firft inventor of harmony efcares our investigation, from the fame caufes which leave us ignorant of thofe who firft invented each particular fcience; becaufe the original inventors could only advance one ftep, a fucceeding difcoverer afterwards made a more fenfible improvement, and the firft imperfect effays in every kind were loft in the more extenfive and ftriking views to which they led. Thus the arts which we now enjoy, are for the moft part far from being due to any particular man, or to any nation excluflively: they are produced by the united and fucceffive endeavours of mankind; they are the refults of fuch continued and united reflections, as have been formed by all men at

all periods and in all nations.

It might, however, be wifhed, that after having afcertain'd, with as much accuracy as poffible, the ftate of ancient mufic by the fmall number of Greek authors which remain to us, the fame application were immediately directed to investigate the firft inconteftable traces of harmony which appear in the fucceeding ages, and to purfue thefe traces from period to period. The products of thefe refearches would doubtlefs be very imperfect, becaufe the books and monuments of the middle ages are by far too few to enlighten that gloomy and barbarous æra; yet thefe difcoveries would ftill be precious to a philofopher, who delights to obferve the human mind in the gradual evolutions of its powers, and the progrefs of its attainments.

The firft compositions upon the laws of harmony which we know, are of no higher antiquity than two ages prior to our own; and they were followed by many others. But none of thefe effays was capable of fatisfying the mind concerning the principles of harmony: they confin'd themfelves almoft entirely to the fingle occupation of collecting rules, without endeavouring to account for them; neither had their analogies one with another, nor their common fource, been perceived; a blind and unenlighten'd experience was the only compafs by which the artift could direct and regulate his courfe.

M. Rameau was the firft who began to tranfufe light and order through this chaos. In the different tones produced by the fame fonorous body, he found the moft probable origin of harmony, and the caufe of that pleafure which we receive from it. His principle unfolded, and fhew'd how the different phenomena of mufic were produced by it: he reduced all the confonances to a fmall number of fimple and fundamental chords, of which the others are only combinations or various arrangements. He has, in fhort, been able to difcover, and render fenfible to others, the mutual dependence between melody and harmony.

Though thefe different topics may be contain'd in the writings of this celebrated artift, and in thefe writings may be underftood by philofophers who are like wife adepts in the art of mufic; ftill, however, fuch philofophers as were not philofophers, and fuch philofophers as were not muficians, have long defir'd to fee thefe objects brought more within the reach of their capacity: fuch is the intention of the treatife I now prefent to the public. I had formerly compos'd it for the ufe of fome friends. As the work appear'd to them clear and methodical, they have engag'd me to publifh it, perfuaded (though perhaps with too much credulity), that it might be ufeful to facilitate the progrefs of initiates in the ftudy of harmony.

This was the only motive which could have determin'd me to publifh a book of which I might without

Prelim.  
Discourf.

<sup>32</sup>  
Delinea-tions of the laws of har-mony recent and imperfect.

<sup>33</sup>  
Its precepts not deduc'd from any principle till by M. Rameau.

<sup>34</sup>  
The author's motives for writing thefe elements.

(§) Though no certainty can be obtain'd what the ancients underftood of harmony, nor in what manner and in what period they praftic'd it; yet it is not without probability, that, both in fpeculation and praftice, they were in poffeffion of what we denominate *counterpoint*. Without fuppoſing this, there are ſome paſſages in the Greek authors which can admit of no ſatisfactory interpretation. See the *Origin and Progrefs of Language*, Vol. II. Befides, we can difcover ſome veſtiges of harmony, however rude and imperfect, in the hiftory of the Gothic ages, and amongst the moſt barbarous people. This they could not have deriv'd from more cultivated countries, becauſe it appears to be incorporated with their national mufic. The moſt rational account, therefore, which can be given, ſeems to be, that it was convey'd in a mechanical or traditionary manner through the Roman provinces from a more remote period of antiquity.

Prelim.  
Discours.

out hesitation assume the honour, if its materials had been the fruits of my own inventions, but in which I can now boast no other merit than that of having developed, elucidated, and perhaps in some respects improved, the ideas of another (c).

35  
improvements  
of this edition.

The first edition of this essay, published 1752, having been favourably received by the world, and copies no longer to be found in the hands of bookellers, I have endeavoured to render this more perfect. The detail which I mean to give of my labour, will present the reader with a general idea of the principle of M. Rameau, of the consequences deduced from it, of the manner in which I have disposed this principle and its consequences; in short, of what is still a-wanting, and might be advantageous to the theory of this amiable art; of what still remains for the learned to contribute towards the perfection of this theory; of the rocks and quicksands which they ought to avoid in this research, and which could serve no other purpose than to retard their progress.

35  
Account of  
the work in  
general.

Every sonorous body, besides its principal found, likewise exhibits to the ear the 12th and 17th major of that found. This multiplicity of different, yet concordant founds, known for a considerable time, constitutes the basis of the whole theory of M. Rameau, and the foundation upon which he builds the whole superstructure of a musical system \*. In these our elements may be seen, how from this experiment one

35  
Rameau's  
origin of  
harmony.

may deduce, by an easy operation of reason, the chief points of melody and harmony; the perfect † chord, as well major as minor; the two ‡ tetrachords employed in ancient music; the formation of our diatonic § scale; the different values ¶ which the same found may have in that scale, according to the turn which is given to the bass \*; the alterations ¶ which we observe in that scale, and the reason why they are totally imperceptible to the ear; the rules peculiar to the mode † major; the difficulty in ‡ intonation of forming three tones § in succession; the reason why two perfect chords are proffered in immediate succession in the diatonic order; the origin of the minor mode, its subordination to the mode major, and its variations; the use of discord §; the causes of such effects as are produced by different kinds of music, whether diatonic, chromatic \*, or enharmonic †; the principles and laws of temperament ‡. In this discourse we can only point out those different objects, the subsequent essay being designed to explain them with the minuteness and precision which they require.

\* See Sy-  
stem.

† See  
Chord.

‡ See Tetra-  
chord.

§ See Dia-  
tonic.

¶ See Va-  
lue.

\* See Bas-  
s.

† See Al-  
teration.

‡ See In-  
tonation.

§ See Tone.

¶ See Dif-  
cord.

\* See Chro-  
matic.

† See En-  
harmonic.

‡ See Tem-  
perament.

One end which we have proposed in this treatise, was not only to place the discoveries of M. Rameau in their most conspicuous and advantageous light, but even in particular respects to render them more simple. For instance, besides the fundamental experiment which we have mentioned above, that celebrated musician, to render the explication of some particular phenomena in music more accessible, had recourse to another experiment; I mean that which shows that a sonorous body struck and put in vibration, forces its 12th and 17th major in descending to divide themselves and produce a tremulous found. The chief use which M. Rameau made of this second experiment was to investigate the origin of the minor mode, and to give

a satisfactory account of some other rules established in harmony; and with respect to this in our first edition we have implicitly followed him: in this we have found means to deduce from the first experiment alone the formation of the minor mode, and besides to disengage that formation from all the questions which were foreign to it.

It is the same case with some other points (as the origin of the chord of the sub-dominant §, and the explication of the seventh in some peculiar respects), upon which it is imagined that we have simplified, and perhaps in some measure extended, the principles of the celebrated artist.

We have likewise banished from this edition, as from the former, every consideration of geometrical, arithmetical, and harmonical proportions and progressions, which authors have endeavoured to find in the mixture and protraction of tones produced by a sonorous body; persuaded as we are, that M. Rameau was under no necessity of paying the least regard to these proportions, which we believe to be not only useless, but even, if we may venture to say so, fallacious when applied to the theory of music. In short, though the relations produced by the octave, the fifth, and the third, &c. were quite different from what they are; though in these chords we should neither remark any progression nor any law; though they should be incommensurable one with another; the protracted tone of a sonorous body, and the multiplied founds which result from it, are a sufficient foundation for the whole harmonic system.

But though this work is intended to explain the theory of music, and to reduce it to a system more complete and more luminous than has hitherto been done, we ought to caution those who shall read this treatise, that they may be careful not to receive of themselves, either by misapprehending the nature of their object, or the end which our endeavours pursue,

We must not here look for that striking evidence which is peculiar to geometrical discoveries alone, and which can be so rarely obtained in these mixed disquisitions, where natural philosophy is likewise concerned: into the theory of musical phenomena there must always enter a particular kind of metaphysics, which these phenomena implicitly take for granted, and which brings along with it its natural obscurity. In this subject, therefore, it would be absurd to expect what is called demonstration: it is an achievement of no small importance, to have reduced the principal facts to a system consistent with itself, and firmly connected in its parts; to have deduced them from one simple experiment; and to have established upon this foundation the most common and essential rules of the musical art. But in another view, if here it be improper to require that intimate and unalterable conviction which can only be produced by the strongest evidence, we remain in the mean time doubtful whether it is possible to elucidate this subject more strongly.

After this declaration, one should not be astonished, that, amongst the facts which are deduced from our fundamental experiment, there should be some which appear immediately to depend upon that experiment, and others which are deduced from it in a way more remote

Prelim.  
Discours.

§ See Sub-  
dominant.

37  
Theoretical  
musicians  
cautioned  
with regard  
to the ad-  
mission of  
mathemati-  
cal or me-  
taphysical  
principles  
in music.

Prelim.  
Discours.

remote and less direct. In disquisitions of natural philosophy, where we are scarcely allowed to use any other arguments, except such as arise from analogy or congruity, it is natural that the analogy should be sometimes more sometimes less sensible: and we will venture to assert, that such a mind must be very improper for philosophy, which cannot recognise and distinguish this gradation and the different circumstances on which it proceeds. It is not even surprising, that in a subject where analogy alone can take place, this conductors should desert us all at once in our attempts to account for certain phenomena. This likewise happens in the subject which we now treat; nor do we conceal the fact, however mortifying, that there are certain points (though there number be but small) which appear still in some degree unaccountable from our principle. Such, for instance, is the procedure of the diatonic scale in descending; the formation of the chord commonly termed the *sixth redundant* \* or *superfluous*, and some other facts of less importance, for which as yet we can scarcely offer any satisfactory account except from experience alone.

\* See Redundant.

Thus, though the greatest number of the phenomena in the art of music appear to be deducible in a simple and easy manner from the protracted tone of sonorous bodies, one ought not perhaps with too much temerity to affirm as yet, that this mixed and protracted tone is *demonstratively* the only original principle of harmony (D). But in the mean time it would not be less unjust to reject this principle, because certain phenomena appear to be deduced from it with less success than others. It is only necessary to conclude from this, either that by future scrutines means may be found for reducing these phenomena to this principle; or that harmony has perhaps some other unknown principle, more general than that which results from the protracted and compounded tone of sonorous bodies, and of which this is only a branch; or lastly, that we ought not perhaps to attempt the reduction of the whole science of music to one and the same principle;

39  
Rameau's primary experiment has not as yet been accounted for all the phenomena of music. Perhaps some other may be necessary.

(D) The *demonstration* of the principles of harmony by M. Rameau was not thus entitled in the exposition which he presented in the year 1749 to the Academy of Sciences, and which that society besides approved with all the eulogiums which the author deserved; the title, as inserted in the register of the academy, was, "A memorial, in which are explained the foundations of a system of music theoretical and practical." It is likewise under this title that it was announced and approved of by the Commissioners, who in their printed report, which the public may read along with M. Rameau's memorial, have never dignified his theory with any other name than that of a *system*, the only name in reality which is expressive of its nature. M. Rameau, who, after the approbation of the academy, has thought himself at liberty to adorn his system with the name of a *demonstration*, did not certainly recollect what the academy has frequently declared; that, in approving any work, it was by no means implied that the principles of that work appeared to them demonstrated. In short, M. Rameau himself, in some writings posterior to what he calls his *demonstration*, acknowledges, that upon particular points in the theory of the musical art, he is under a necessity of having recourse to analogy and aptitude; this excludes every idea of demonstration, and restores the theory of the musical art, exhibited by M. Rameau, to the class in which it can only be ranked with propriety, I mean the class of probabilities.

(†) Had the utility of the preliminary discourse in which we are now engaged been less important and obvious than it really is, we should not have given ourselves the trouble of translating, nor our readers that of perusing it. But it must be evident to every one, that the cautions here given, and the advices offered, are no less applicable to students than to authors. The first question here decided, is, Whether pure mathematics can be successfully applied to the theory of music. The author is justly of a contrary opinion. It may certainly be doubted with great justice, whether the solid contents of sonorous bodies, and their degrees of cohesion or elasticity, can be ascertained with sufficient accuracy to render them the subjects of musical speculation, and to determine their effects with such precision as may render the conclusions deduced from them geometri-

which, however, is the natural effect of an impatience so frequent even among philosophers themselves, which induces them to take a part for the whole, and to judge of objects in their full extent by the greatest number of their appearances.

In those sciences which are called *physico-mathematical*, (and amongst this number perhaps the science of sounds may be placed), there are some phenomena which depend only upon one single principle, and one single experiment: there are others which necessarily suppose a greater number both of experiments and principles, whose combination is indispensable in forming an exact and complete system; and music perhaps is in this last case. It is for this reason, that whilst we bestow on M. Rameau all due praise, we should not at the same time neglect to stimulate the learned in their endeavours to carry them still to higher degrees of perfection, by adding if it is possible such improvements as may be wanting to consummate the science.

Whatever the result of their efforts may be, the reputation of this intelligent artist has nothing to fear: he will still have the advantage of being the first who rendered music a science worthy of philosophical attention; to have made its practice more simple and easy; and to have taught musicians to employ in this subject the light of reason and analogy.

We would the more willingly persuade those who are skilled in theory and eminent in practice to extend and improve the views of him who before them pursued and pointed out the career, because many amongst them have already made laudable attempts, and have even been in some measure successful in diffusing new light through the theory of this enchanting art. It was with this view that the celebrated Tartini presented us in 1754 with a treatise of harmony, founded on a principle different from that of M. Rameau. This principle is the result of a most beautiful experiment (†). If at once two different sounds are produced from two instruments of the same kind, these two

Prelim.  
Discours.

39  
Tartini's experiment.

sounds

Prelim. Discourse. sounds generate \* a third different from both the others. They have inserted in the *Encyclopédie*, under the article *Fundamental*, a detail of this experiment according to M. Tartini; and we owe to the public an information of which in composing this article we were ignorant: M. Rameau, a member of the Royal Society at Montpellier, had presented to that society in the year 1753, before the work of M. Tartini had appeared, a memorial printed the same year, and where

See Gene. ite. 40  
s discovery originally due  
to Rameau. may be found the same experiment displayed at full length. In relating this fact, which it was necessary for us to do, it is by no means our intention to detract in any degree from the reputation of M. Tartini; we are persuaded that he owes this discovery to his own researches alone: but we think ourselves obliged in honour to give a public testimony in favour of him who was the first in exhibiting this discovery.

But whatever be the case, it is in this experiment that M. Tartini attempts to find the origin of harmony: his book, however, is written in a manner so obscure, that it is impossible for us to form any judgment of it; and we are told that others distinguished for their knowledge of the science are of the same opinion. It were to be wished that the author would engage some fan of letters, equally practised in music and skilled in the art of writing, to unfold these ideas which he has not discovered with sufficient perspicuity, and from whence the art might perhaps derive considerable advantage if they were placed in a proper light. Of this I am so much the more persuaded, that even though this experiment should not be regarded by others in the same view with M. Tartini as the foundation of the musical art, it is nevertheless extremely probable that one might use it with the greatest advantage to enlighten and facilitate the practice of har-

mony (x).

In exhorting philosophers and artists to make new attempts for the advancement of the theory of music, we ought at the same time to let them know the danger of mistaking what is the real end of their researches. Experience is the only foundation upon which they can proceed; it is alone by the observation of facts, by bringing them together in one view, by shewing their dependency upon one, if possible, or at least upon a very small number of primary facts, that they can reach the end to which they so ardently aspire, the important end of establishing an exact theory of music, where nothing is wanting, nothing obscure, but every thing discovered in its full extent, and in its proper light. The philosopher who is properly enlightened, will not give himself the trouble to explain such facts as are less essential to his art, because he can discern those on which he ought to expatiate for its proper illustration. If one would estimate them according to their proper value, he will only find it necessary to cast his eyes upon the attempts of natural philosophers who have discovered the greatest skill in their science; to explain, for instance, the multiplicity of tones produced by sonorous bodies. These sages, after having remarked (what is by no means difficult to conclude) that the universal vibration of a musical string is a mixture of several partial vibrations, from thence infer, that a sonorous body ought to produce a multiplicity of tones, as it really does. But why should this multiplied sound only appear to contain three, and why these three preferable to others? Some pretend that there are particles in the air, which, by their different degrees of magnitude and texture, being naturally susceptible of different oscillations, produce the multiplicity of found

41  
Mechanical  
conclusions  
inadequate  
to the situa-  
tion of mu-  
sical phae-  
nomena.

cally true. It is admitted, that sound is a secondary quality of matter, and that secondary qualities have no obvious connection which we can trace with the sensations produced by them. Experience, therefore, and not speculation, is the grand criterion of musical phenomena. For the effects of geometry in illustrating the theory of music, (if any will still be so credulous as to pay them much attention), the English reader may consult Smith's *Harmonics*, Malcom's dissertation on music, and Pleydel's treatise on the same subject inserted in a former edition of this work. Our author next treats of the famous discovery made by Sig. Tartini, of which the reader may accept the following compendious account.

If two sounds be produced at the same time properly tuned and with due force, from their conjunction a third sound is generated, so much more distinctly to be perceived by delicate ears as the relation between the generating sounds is more simple; yet from this rule we must except the unison and octave. From the fifth is produced a sound unison with its lowest generator; from the fourth, one which is an octave lower than the highest of its generators; from the third major, one which is an octave lower than its lowest; and from the sixth minor (whose highest note forms an octave with the lowest in the third formerly mentioned) will be produced a sound lower by a double octave than the highest of the lesser sixth; from the third minor, one which is double the distance of a greater third from its lowest; but from the sixth major (whose highest note makes an octave to the lowest in the third minor), will be produced a sound only lower by double the quantity of a greater third, than the highest; from the second major, a sound lower by a double octave than the lowest; from a second minor, a sound lower by triple the quantity of a third major than the highest; from the interval of a diatonic or greater semitone, a sound lower by a triple octave than the highest; from that of a minor or chromatic semitone, a sound lower by the quantity of a fifth four times multiplied than the lowest, &c. &c. But that these musical phenomena may be tried by experiments proper to ascertain them, two hautboys tuned with scrupulous exactness must be procured, whilst the musicians are placed at the distance of some paces one from the other, and the hearers in the middle. The violin will likewise give the same chords, but they will be less distinctly perceived, and the experiment more fallacious, because the vibrations of other strings may be supposed to enter into it.

If our English reader should be curious to examine these experiments and the deductions made from them in the theory of music, he will find them clearly explained and illustrated in a treatise called *Principles and powers of harmony*, printed at London in the year 1771.

(x) See the article FUNDAMENTAL in the French *Encyclopédie*, vol. vii. p. 63.

Prelim.  
Discours.

in question. But what do we know of all this hypothetical doctrine? And though it should even be granted, that there is such a diversity of tension in these aerial particles, how should this diversity prevent them from being all of them confounded in their vibrations by the motions of a sonorous body? What then should be the result, when the vibrations arrive at our ears, but a confused and inappreciable † noise, where one could not distinguish any particular sound? (r)

† See In-  
appreciable.42  
Metaphysical  
conclu-  
sions less  
adequate.

If philosophical musicians ought not to lose their time in searching for mechanical explanations of the phenomena in music, explanations which will always be found vague and unsatisfactory; much less is it their province to exhaust their powers in vain attempts to rise above their sphere into a region still more remote from the prospect of their faculties, and to lose themselves in a labyrinth of metaphysical speculations upon the causes of that pleasure which we feel from harmony. In vain would they accumulate hypotheses on hypotheses, to find a reason why some chords should please us more than others. The futility of these supposititious accounts must be obvious to every one who has the least penetration. Let us judge of the rest by the most probable which has till now been invented for that purpose. Some ascribe the different degrees of pleasure which we feel from chords, to the more or less frequent coincidence of vibrations; others to the relations which these vibrations have among themselves as they are more or less simple. But why should this coincidence of vibrations, that is to say, their simultaneous impulse on the same organs of sensation, and the accident of beginning frequently at the same time, prove so great a source of pleasure? Upon what is this gratuitous supposition founded? And though one should grant it, would it not follow from thence, that the same chord should successively and rapidly affect us with contrary sensations, since the vibrations are alternately coincident and discrepant? On the other hand, how should the ear be so sensible to the simplicity of relations, whilst, for the most part, these relations are entirely unknown to him whose organs are notwithstanding sensibly affected with the charms of agreeable music? We may conceive without difficulty how the eye judges of relations; but how does the ear form similar judgments? Besides, why should certain chords which are extremely pleasing in themselves, such as the fifth, lose almost nothing of the pleasure which they give us, when they are altered, and of consequence when the simplicity of their relations are destroyed; whilst other chords, which are likewise extremely agreeable, such as the third, become harsh almost by the smallest alteration; nay, whilst the most perfect and the most agreeable of all chords, I mean the octave, cannot suffer the most inconsiderable change? Let us in sincerity confess our ignorance concerning the genuine causes of these effects.

The metaphysical conjectures concerning the acoustic organs are probably in the same predicament with those which are formed concerning the organs of vision, if one may speak so, in which philosophers have even till now made such inconsiderable progress, and in all likelihood will not be surpassed by their successors (c).

Prelim.  
Discours.

Since the theory of music, even to those who confine themselves within its limits, implies questions from which every wise musician will abstain, with much greater reason should they avoid idle excursions beyond the boundaries of that theory, and endeavours to investigate between music and the other sciences chimerical relations which have no foundation in nature. The singular opinions advanced upon this subject by some even of the most celebrated musicians, deserve not to be rescued from oblivion, nor refuted; and ought only to be regarded as a new proof how far men of genius may deviate from truth and taste, when they engage in subjects of which they are ignorant.

The rules which we have attempted to establish concerning the track which every one ought to pursue in the theory of the musical art, may suffice to shew our readers the end which we have proposed, and which we have endeavoured to attain in this work. We have nothing to do here (for it is proper that we repeat it), we have nothing to do with the mechanical principles of protracted and harmonic tones produced by sonorous bodies; principles which, till now, have been explored in vain, and which perhaps may be long explored with the same success: we have still left to do with the metaphysical causes of those pleasing sensations which are impressed on the mind by harmony; causes which are still less discovered, and which, according to all appearances, will remain latent in perpetual obscurity. We are alone concerned to show how the chief and most essential laws of harmony may be deduced from one single experiment; and for which, if we may speak so, preceding artists have been under a necessity of groping in the dark.

With an intention to render this work as generally useful as possible, I have endeavoured to adapt it to the capacity even of those who are absolutely unacquainted with music. To accomplish this design, it appeared necessary to pursue the following plan.

To begin with a short introduction, in which are defined the technical terms most frequently used in this art; such as *chord, harmony, tone, third, fifth, octave, &c.*

Afterwards to enter into the theory of harmony, which is explained according to M. Rameau, with all possible perspicuity. This is the subject of the *First Part*; which, as well as the introduction, presupposes no other knowledge of music than that of the names and powers of the syllables *ut, re, mi, fa, sol, la, si,* which

43  
Plan of the  
treatise.

(r) One may see this subject treated at greater length in the *Encyclopédie*, at the word *FUNDAMENTAL*.

(c) To these arguments others may still be added, which may be found under the article *CONSONANCE* in the *Encyclopédie*, where this question has been very successfully treated by M. Rousseau.—† Thus far the author; but with respect to his strictures concerning the metaphysics of vision, the little progress which philosophers have made in it, and the little probability of their being surpassed by their successors, we cannot forbear to remark, that M. D'Alembert would have been less precipitate and sanguine in his decisions had he read Dr Reid's *Inquiry into the human mind on the principles of common sense*.

Prelim. Discourse. which all the world knows (†). The theory of harmony requires some arithmetical calculations, which are necessary for comparing sounds one with another. These calculations are very short, extremely simple, and conducted in such a manner as to be sensibly comprehended by every one; they demand no operation but what is clearly explained, and which every school-boy with the slightest attention may perform. Yet, that even the trouble of this may be spared to such as are not disposed to take it, I have not inserted these calculations in the body of the treatise, but transferred them to the notes, which the reader may omit, if he can satisfy himself by taking for granted the propositions contained in the work, which will be found proved in the notes.

These calculations I have not endeavoured to multiply; I could even have wished to suppress them, if it had been possible: so much did it appear to me to be apprehended that my readers might be misled upon this subject, and might either believe themselves, or at least suspect me of believing, all this arithmetic necessary to form an artist. Calculations may indeed facilitate the understanding of certain points in the theory, as of the relations between the different notes in the gammut and of the temperament; but the calculations necessary for treating of these points are so simple, and, to speak more properly, of so little importance, that nothing can require a less minute or ostentatious display. Do not let us imitate those musicians who, believing themselves geometers, or those geometers who, believing themselves musicians, fill their writings with figures upon figures; imagining, perhaps, that this apparatus is necessary to the art. The propensity of adorning their works with a false air of science, can only impose upon credulity and ignorance, and serve no other purpose but to render their treatises more obscure and less instructive. In the character of a geometer, I think I have some right to protest here (if I may be permitted to express myself in this manner) against such ridiculous abuse of geometry in music.

44 This I may do with so much more reason, that in this subject the foundations of those calculations are in some manner hypothetical, and can never arise to a degree of certainty above hypothesis. The relation of the octave as 1 to 2, that of the fifth as 2 to 3, that of the third major as 4 to 5, &c. are not perhaps the genuine relations established in nature; but only relations which approach them, and such as experience can discover. For are the results of experience any thing more but mere approaches to truth?

But happily these approximated relations are sufficient, though they should not be exactly agreeable to

truth, for giving a satisfactory account of those phenomena which depend on the relations of sound; as in the difference between the notes in the gammut, of the alterations necessary in the fifth and third, of the different manner in which instruments are tuned, and other facts of the same kind. If the relations of the octave, of the fifth, and of the third, are not exactly such as we have supposed them, at least no experiments can prove that they are not so; and since these relations are signified by a simple expression, since they are besides sufficient for all the purposes of theory, it would not only be useless, but even contrary to sound philosophy, should any one incline to invent other relations, to form the basis of any system of music less easy and simple than that which we have delineated in this treatise.

The second part contains the most essential rules of composition\*, or in the other words the practice of harmony. These rules are founded on the principles laid down in the first part; yet those who wish to understand no more than is necessary for practice, without exploring the reasons why such practical rules are necessary, may limit the objects of their study to the introduction and the second part. They who have read the first part, will find at every rule contained in the second, a reference to that passage in the first where the reasons for establishing that rule are given.

That we may not present at once too great a number of objects and precepts, I have transferred to the notes in the second part several rules and observations which are less frequently put in practice, which perhaps it may be proper to omit till the treatise is read a second time, when the reader is well acquainted with the essential and fundamental rules explained in it.

This second part, strictly speaking, presupposes, no more than the first, any habit of singing, nor even any knowledge of music; it only requires that one should know, not even the rules and manner of intonation, but merely the position of the notes in the cleff *sa* on the fourth line, and of that of *sol* upon the second: and even this knowledge may be acquired from the work itself; for in the beginning of the second part I explain the positions of the cleffs and of the notes. Nothing else is necessary but to render it a little familiar to our memory, and we shall have no more difficulty in it.

It would be wrong to expect here all the rules of composition, and especially those which direct the composition of music in several parts, and which, being less levere and indispensable, may be chiefly acquired by practice, by studying the most approved models, in an elementary style.

[ c ]

(†) The names of the seven notes used by the French are here retained, and will indeed be continued thro' the whole ensuing work; as we imagine, that, if properly associated with the sounds which they denominate, they will tend to impress these sounds more distinctly on the memory of the scholar than the letters C, D, E, F, G, A, B, from which characters, except in *sol-fa*'ing the notes in the diatonic series are generally named in Britain. Amongst us, in the progress of intonation, the syllables *ut, re, and, fa*, have been omitted, by which means the teachers of church-music have rendered it still more difficult to express by the four remaining denominations the various changes of the semitones in the octave. As these artificially change their places, the seven syllables above-mentioned also diversify their powers, and are variously arranged according to the intervals in which the notes they are intended to signify may be placed.

For an account of these variations, see *Roussau's* musical dictionary, article *GAMME*. See also the *Essay* towards a rational system of music, by John Holden, part i. chap. 1.

44 Mathematical conclusions not transferable to sensible objects without caution.

45 Some rules, on account of their intricacy, transferred to the notes.

46 All the rules of composition to be expected in an elementary style.

Definitions:

by the assistance of a proper master, but above all by the cultivation of the ear and of the taste. This treatise is properly nothing else, if I may be allowed the expression, but the rudiments of music, intended for explaining to beginners the fundamental principles, not the practical detail of composition. Those who wish to enter more deeply into this detail, will either find it in Mr Rameau's treatise of harmony, or in the code of music which he published more lately (1), or lastly in the explication of the theory and practice of music by M. Bethizi (2): this last book appears to me clear and methodical.

One may look upon it (with respect to a practical detail) as a supplement to my own performance; I do this justice to the author with so much more cheerfulness, as he is entirely unknown to me, and as his animadversions upon my work appear to me less severe than it deserved (3).

47  
Nature the essential mistress of musical composition.

Is it necessary to add, that, in order to compose music in a proper taste, it is by no means enough to have familiarized with much application the principles explained in this treatise? Here can only be learned the mechanism of the art; it is the province of nature alone to accomplish the rest. Without her assistance, it is no more possible to compose agreeable music by having read these elements, than to write verses in a proper manner with the Dictionary of Richelieu. In one word, it is the elements of music alone, and not the principles of genius, that the reader may expect to find in this treatise.

Such was the aim I pursued in its composition, and such should be the ideas of the reader in its perusal. Once more let me add, that to the discovery of its fundamental principles I have not the remotest claim. The sole end which I proposed was to be useful; to reach that end, I have omitted nothing which appeared necessary, and I should be sorry to find my endeavours unsuccessful.

DEFINITIONS OF SEVERAL TECHNICAL TERMS.

I. *What is meant by Melody, by Clord, by Harmony, by Interval.*

48  
Melody, what.

1. Melody is nothing else but a series of sounds which succeed one to another in a manner agreeable to the ear.

49  
Chord and harmony, what.

2. That is called a *chord* which arises from the mixture of several sounds heard at the same time; and harmony is properly a series of chords which in their succession one to another delights the ear. A single chord is likewise sometimes called *harmony*, to signify

the coalescence of sounds which that chord creates, and the sensation produced in the ear by that coalescence. We shall occasionally use the word *harmony* in this last sense, but in such a manner as never to leave our meaning ambiguous.

3. In melody and harmony, the distance between one sound and another is called an *interval*; and this is increased or diminished as the sounds between which it intervenes are higher or lower one than the other.

4. That we may learn to distinguish the intervals, and the manner of perceiving them, let us take the ordinary scale *ut, re, mi, fa, sol, la, si, UT*, which is *C, D, E, F, G, A, B, C*, which every person whose ear or voice is not extremely false naturally modulates. These are the observations which will occur to us in fingering this gammut.

The sound *re* is higher or sharper than the sound *ut*, the sound *mi* higher than the sound *re*, the sound *fa* higher than the sound *mi*, &c. and so through the whole octave; so that the interval or the distance from the sound *ut* to the sound *re*, is less than the interval or distance between the sound *ut* and the sound *mi*, the interval from *ut* to *mi* is less than that between *ut* and *fa*, &c. and in short that the interval from the first to the second *ut* is the greatest of all. To distinguish the first from the second *ut*, I have marked the last with capital letters.

5. In general, the interval between two sounds is proportionably greater, as one of these sounds is higher or lower with relation to the other: but it is necessary to observe, that two sounds may be equally high or low, though unequal in their force. The string of a violin touched with a bow produces always a sound equally high, whether strongly or faintly struck; the sound will only have a greater or lesser degree of strength. It is the same with vocal modulation; let any one form a sound by gradually impelling or swelling the voice, the sound may be perceived to increase in its energy, whilst it continues always equally low or equally high.

6. We must likewise observe concerning the scale, that the intervals between *ut* and *re*, between *re* and *mi*, between *fa* and *sol*, between *sol* and *la*, between *la* and *si*, are equal, or at least nearly equal; and that the intervals between *mi* and *fa*, and between *si* and *ut*, are likewise equal among themselves, but consist almost only of half the former. This fact is known and recognized by every one: the reason for it shall be given in the sequel; in the mean time every one may ascertain its reality by the assistance of an experiment (4).

7. It

(1) From my general recommendation of this code, I except the reflections on the principles of sound which are at the end, and which I should not advise any one to read.

(2) Printed at Paris by Lambert in the year 1754.

(3) That criticism and my answers may be seen in the *Journeaux Economiques* of 1752.

(4) This experiment may be easily tried. Let any one sing the scale of *ut, re, mi, fa, sol, la, si, UT*, which is *C, D, E, F, G, A, B, C*, it will be immediately observed without difficulty, that the last four notes of the octave *sol, la, si, UT*, are quite similar to the first *ut, re, mi, fa*; inasmuch, that if, after having sung this scale, one would choose to repeat it, beginning with *ut* in the same tone which was occupied by *sol* in the former scale, the note *re* of the last scale would have the same sound with the note *la* in the first, the *mi* with the *si*, and the *fa* with the *ut*.

From whence it follows, that the interval between *ut* and *re*, is the same as between *sol* and *la*; between *re* and

Definitions.

50  
Account of the simple intervals.

51  
The distinction between strong and acute and faint or grave.

52  
Between tonic and semitonic intervals.



Definitions. 7. It is for this reason that they have called the interval from *mi* to *fa*, and from *fi* to *ut*, a semitone; whereas those between *ut* and *re*, *re* and *mi*, *fa* and *sol*, *sol* and *la*, *la* and *si*, are tones.

\* See Inter-  
val. The tone is likewise called a *second major* \*, and the semitone a *second minor* †.

8. To descend or rise diatonically, is to descend or rise from one found to another by the interval of a tone or of a semitone, or in general by seconds, whether major or minor; as from *re* to *ut*, or from *ut* to *re*; from *fa* to *mi*, or from *mi* to *fa*.

II. The Terms by which the different Intervals of the Gammut are denominated.

<sup>53</sup> Third minor, what. 9. An interval composed of a tone and a semitone, as from *mi* to *sol*, from *la* to *ut*, or from *re* to *fa*, is called a *third minor*.

<sup>54</sup> Third major, what. An interval composed of two full tones, as from *ut* to *mi*, from *fa* to *la*, or from *sol* to *si*, is called a *third major*.

<sup>55</sup> Fourth, what. An interval composed of two tones and a semitone, as from *ut* to *fa*, or from *sol* to *ut*, is called a *fourth* ‡.

<sup>56</sup> Triton, what. An interval consisting of three full tones, as from *fa* to *si*, is called a *triton* or *fourth redundant*.

<sup>57</sup> Fifth, what. An interval consisting of three tones and a semitone, as from *ut* to *sol*, from *fa* to *ut*, from *re* to *la*, or from *mi* to *si*, &c. is called a *fifth*.

<sup>58</sup> Sixth minor, what. An interval composed of three tones and two semitones, as from *mi* to *ut*, is called a *sixth minor*.

<sup>59</sup> Sixth major, what. An interval composed of four tones and a semitone, as from *ut* to *la*, is called a *sixth major*.

<sup>60</sup> Seventh minor, what. An interval consisting of four tones and two semitones, as from *re* to *ut*, is called a *seventh minor*.

An interval composed of five tones and two semi-

tones, as from *ut* to *si*, is called a *seventh major*.

And in short, an interval consisting of five tones and two semitones, as from *ut* to *UT*, is called an *octave*.

A great many of the intervals which have now been mentioned, are still signified by other names, as may what. be seen in the beginning of the second part; but those which we have now given are the most common, and the only terms which our present purpose demands. what. 10. Two sounds equally high, or equally low, however unequal in their force, are said to be in *unison* one what.

11. If two sounds form between them any interval, whatever it be, we say, that the highest when ascending is in that interval with relation to the lowest; and when descending, we pronounce the lowest in the same interval with relation to the highest. Thus in the third minor *mi, sol*, where *mi* is the lowest and *sol* the highest sound, *sol* is a third minor from *mi ascending*, and *mi* is third minor from *sol in descending*.

12. In the same manner, if speaking of two sonorous bodies, we should say, that the one is a fifth above the other in *ascending*, this infers that the found given by the one is at the distance of a fifth *ascending* from the found given by the other.

III. Of Intervals greater than the Octave.

13. If after having sung the scale *ut, re, mi, fa, sol, la, si, UT*, one would carry this scale still farther in ascent, it would be discovered without difficulty that a new scale would be formed, *UT, RE, MI, FA, &c.* entirely similar to the former, and of which the sounds will be an octave ascending, each to its correspondent note in the former scale: thus *RE*, the second note of the second scale, will be an octave in ascent to the *re* of the first scale.

[ c 2 ] of

and *mi*, as between *la* and *si*; and *mi* and *fa*, as between *si* and *ut*.

It will likewise be found, that from *re* to *mi*, from *fa* to *sol*, there is the same interval as from *ut* to *re*. To be convinced of this, we need only sing the scale once more; then sing it again, beginning with *ut*, in this last scale, in the same tone which was given to *re* in the first; and it will be perceived, that the *re* in the second scale will have the same sound, at least as far as the ear can discover, with the *mi* in the former scale; from whence it follows, that the interval between *re* and *mi* is, at least as far as the ear can perceive, equal to that between *ut* and *re*. It will also be found, that the interval between *fa* and *sol* is, so far as our sense can determine, the same with that between *ut* and *re*.

This experiment may perhaps be tried with some difficulty by those who are not inured to form the notes and change the key; but such may very easily perform it by the assistance of a harpsichord, by means of which the performer will be saved the trouble of retaining the sounds in one intonation whilst he performs another. In touching upon this harpsichord the keys *sol, la, si, ut*, and in performing with the voice at the same time *ut, re, mi, fa*, in such a manner that the same found may be given to *ut* in the voice with that of the key *sol* in the harpsichord, it will be found that *re* in the vocal intonation shall be the same with *la* upon the harpsichord, &c.

It will be found likewise by the same harpsichord, that if one should sing the scale beginning with *ut* in the same tone with *mi* on the instrument, the *re* which ought to have followed *ut*, will be higher by an extremely perceptible degree than the *fa* which follows *mi*: thus it may be concluded, that the interval between *mi* and *fa* is less than that between *ut* and *re*; and if one would rise from *fa* to another sound which is at the same distance from *fa* as *fa* from *mi*, he would find in the same manner, that the interval from *mi* to this new found is almost the same as that between *ut* and *re*. The interval then from *mi* to *fa* is nearly half of that between *ut* and *re*.

Since then, in the scale thus divided, 
$$\begin{matrix} ut, re, mi, fa, \\ sol, la, si, Ut, \end{matrix}$$
 the first division is perfectly like the last; and since the intervals between *ut* and *re*, between *re* and *mi*, and between *fa* and *sol*, are equal; it follows, that the intervals between *sol* and *la*, and between *la* and *si*, are likewise equal to every one of the three intervals between *ut* and *re*, between *re* and *mi*, and between *fa* and *sol*; and that the intervals between *mi* and *fa* and between *si* and *ut* are also equal, but that they only constitute one half of the others.

Definitions of the first scale; in the same manner ML shall be the octave to *mi*, &c. and so of the rest.

64  
Ninth, what.

14. As there are nine notes from the first *ut* to the second RE, the interval between these two sounds is called a *ninth*, and this ninth is composed of six full tones and two semitones. For the same reason the interval from *ut* to FA is called an *eleventh*, and the interval between *ut* and SOL, a *twelfth*, &c.

65  
Eleventh and twelfth, what.

It is plain that the *ninth* is the octave of the *second*, the *eleventh* of the *fourth*, and the *twelfth* of the *fifth*, &c.

§ See Interval and Double Octave.

The octave above the octave of any sound is called a *double octave*; the octave of the double octave is called a *triple octave*; and so of the rest.

The double octave is likewise called a *seventeenth*; and for the same reason the double octave of the third is called a *seventeenth*, the double octave of the fifth a *nineteenth*, &c. (n)

#### IV. What is meant by Sharps and Flats.

66  
Sharp and flats, what. See Interval.

15. It is plain that one may imagine the five tones which enter into the scale, as divided each into two semitones; thus one may advance from *ut* to *re*, forming in his progress an intermediate sound, which shall be higher by a semitone than *ut*, and lower in the same degree than *re*. A sound in the scale is called *sharp*, when it is raised by a semitone; and it is marked with this character ♯: thus *ut* ♯ signifies *ut sharp*; that it is to say, *ut* raised by a semitone above

its pitch in the natural scale. A sound in the scale depressed by a semitone is called *flat*, and is marked thus, ♭: thus *la* ♭ signifies *la flat*, or *la* depressed by a semitone.

#### V. What is meant by Consonances and Dissonances.

67  
Consonance, what. See Chord.

16. A chord composed of sounds whose union or coalescence pleases the ear is called a *consonance*; and the sounds which form this chord are said to be consonant one with relation to the other. The reason of this denomination is, that a chord is found more perfect, as the sounds which form it coalesce more closely among themselves.

17. The octave of a sound is the most perfect of consonances of which that sound is susceptible; then the fifth, afterwards the third, &c. This is a fact founded on experiment.

68  
Dissonance, what. See Discord.

18. A number of sounds simultaneously produced whose union is displeasing to the ear is called a *dissonance*, and the sounds which form it are said to be dissonant one with relation to the other. The second, the triton, and the seventh of a sound, are dissonant with relation to it. Thus the sounds *ut re*, *ut fa*, or *fa fa*, &c. simultaneously heard, form a dissonance. The reason which renders dissonance disagreeable, is, that the sounds which compose it seem by no means coalescent to the ear, and are heard each of them by itself as distinct sounds, tho' produced at the same time.

## P A R T

(b) Let us suppose two vocal strings formed of the same matter, of the same thickness, and equal in their tension, but unequal in their length, it will be found by experience,

1<sup>st</sup>, That if the shortest is equal to half the longest, the sound which it will produce must be an octave above the sound produced by the longest.

2<sup>dly</sup>, That if the shortest constitutes a third part of the longest, the sound which it produces must be a twelfth above the sound produced by the longest.

3<sup>dly</sup>, That if it constitutes the fifth part, its sound will be a seventeenth above.

Besides, it is a truth demonstrated and generally admitted, that in proportion as one musical string is less than another, the vibrations of the least will be more frequent (that is to say, its departures and returns through the same space), in the same time; for instance, in an hour, a minute, a second, &c. in such a manner that one string which constitutes a third part of another, forms three vibrations, whilst the largest has only accomplished one. In the same manner a string which is one half less than another, performs two vibrations, whilst the other only completes one; and a string which is only the fifth part of another, will perform five vibrations in the same time which is occupied by the other in one.

From thence it follows, that the sound of a string is proportionally higher or lower, as the number of its vibrations is greater or smaller in a given time; for instance, in a second.

It is for that reason that if we represent any sound whatever by 1, one may represent the octave above by 2, that is to say, by the number of vibrations formed by the string which produces the octave, whilst the longest string only vibrates once; in the same manner we may represent the twelfth above the sound 1 by 3, the seventeenth major above by 5, &c. But it is very necessary to remark, that by these numerical expressions, we do not pretend to compare sounds as such; for sounds in themselves are nothing but mere sensations, and it cannot be said of any sensation that it is double or triple to another: thus the expressions 1, 2, 3, &c. employed to denominate a sound, its octave above, its twelfth above, &c. signify only, that if a string performs a certain number of vibrations, for instance, in a second, the string which is in the octave above shall double the number in the same time, the string which is in the twelfth above shall triple it, &c.

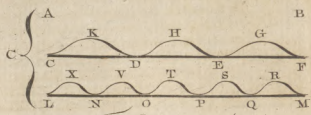
Thus to compare sounds among themselves is nothing else than to compare among themselves the numbers of vibrations which are formed in a given time by the strings that produce these sounds.

*tone tone semitone tone tone tone semitone*

A ut re mi fa sol la si ut

B ut re mi fa sol la si ut re mi fa sol &c

Scale first. Scale second.



The Chromatic Species.

The diatonic Scale of the Greeks.  
 D Si ut Re Mi Fa Sol La  
 Sol ut Sol ut Fa ut Fa  
 The fundamental bass.

Scale.  
 K Sol Sol &c.  
 ut Mi Sol &c.  
 The fundamental bass.

E ut re mi fa sol sol la si ut  
 ut sol ut fa ut sol re sol ut  
 The fundamental bass

Scale  
 L ut mi si &c  
 ut mi sol &c  
 The fundamental bass.

F ut, ut\*, re, re\*, mi, mi\*, fa\*, sol, sol\*, la, la\*, si, si\*, ut, ut\*, re, re\*, mi, mi\*,  
 Scale first. Scale second.

The first Scale of the minor mode.  
 G Sol La si ut Re Mi Fa  
 Mi La mi La Re La Re  
 The fundamental bass.

Scale  
 N mi b mi mi mi mi  
 ut ut la ut ut  
 The fundamental bass.

The second scale of the minor mode.  
 H La si ut re mi mi fa\* sol\* la  
 La mi la re la mi si mi la  
 The fundamental bass.

Scale.  
 M fa mi mi re  
 fa ut mi si  
 The fundamental bass.

I ut re mi fa sol la si ut  
 ut sol ut fa ut re sol ut

ut O ut P Q

Sol la Sol

R S T 2<sup>d</sup> Measure 1<sup>st</sup> Measure 1<sup>st</sup> Time 2<sup>d</sup> T. 3<sup>d</sup> T.

with two Times

X Y

Squibwe Minims Crotchets Quavers Pointed Note

Barr 1<sup>st</sup> B. 2<sup>d</sup> B. 3<sup>d</sup> B. 4<sup>th</sup> B. 5<sup>th</sup>

Z

Barr 1<sup>st</sup> 2<sup>d</sup> 3<sup>d</sup> 4<sup>th</sup> 5<sup>th</sup> 6<sup>th</sup> 7<sup>th</sup>

I. II. III. IV. V. VI. VII. VIII. IX. X.

XI. XII. XIII. XIV. XV. XVI. XVII.

XVIII. XIX. XX. XXI. XXII. XXIII. XXIV.

XV. XVI. XVII. XVIII.

Treble part

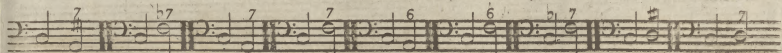
Fundamental Bass

to descend by thirds to descend or rise by 3<sup>rd</sup> or 4<sup>th</sup>

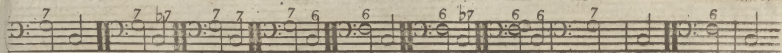
# MUSIC

Plate CLXXXVIII

XXIX. XXX. XXXI. XXXII. XXXIII. XXXIV. XXXV. XXXVI. XXXVII.



XXXVIII. XXXIX. XL. XLI. XLII. XLIII. XLIV. XLV. XLVI.



*perfect Cadence imperfect Cadence*

XLVII. XLVIII. XLIX. L. LI.



*Treble part*

*Treble*

*Treble*

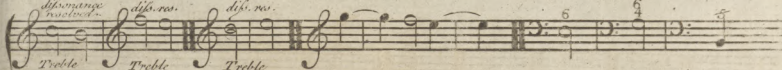
*Treble*

*Fundamental Bass*

*Fund. Bass*

*Fund. Bass*

LII. LIII. LIV. LV. LVI. LVII. LVIII.



*Treble*

*Treble*

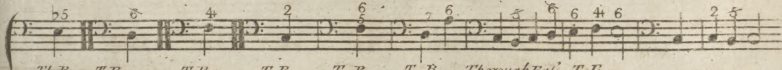
*Treble*

*Fundamental B. Fund. B.*

*Fund. B.*

*Fund. B. F. B. F. B.*

LIX. LX. LXI. LXII. LXIII. LXIV. LXV. LXVI.



*T. B.*

*T. B.*

*T. B.*

*T. B.*

*T. B.*

*T. B.*

*T. B.*

*Thorough Bass*

*T. B.*

*F. B.*

*F. B.*

*F. B.*

*F. B.*

*F. B.*

*F. B.*

*Fundamental Bass*

*F. B.*

LXVII.

LXVIII.

Trible. Treble.

Through Bafs Tho' B.

Fundamental Bafs Fund. B.

LXIX.

LXX.

LXXI.

The Key The Senfible Note Key T. B. Sen. N. Key Th. B.

Fund. B. Fund. B.

LXXII.

LXXIII.

LXXIV.

LXXV.

F. B. F. B. F. B. Broken Cadence F. B. Interrupted Cadence

LXXVI.

LXXVII.

LXXVIII.

LXXIX.

LXXX.

LXXXI.

LXXXII.

LXXXIII.

LXXXIV.

LXXXV.

T. B. F. B. T. B. T. B. F. B. F. B. F. B. F. B. F. B. F. B. F. B. F. B. F. B. F. B. F. B. F. B.

Fund. B. F. B. F. B. F. B. F. B. F. B. F. B. F. B. F. B. F. B. F. B. F. B.

MUSIC.

Plate CXC.

LXXXVI. LXXXVII.

LXXXVIII.

LXXXIX.

Cromatic modulation descending.

Cromatic modulation ascending.

T.B. T.B. The Treble The Treble

F.B. F.B. Fund. B. Fund. B.

XC.

XCI.

Treble Fund. B.

T. B.

Fund. B.

Fund. B.

XCII.

F. B. Treble.

Fund. B.

XCIII.

XCIV.

XCV.

Treble Th. B. F.B.

Fund. B.

F.B.

Fund. B.

F.B.

En fin, il est en ma puissance, Ce fatal enne mi, Ce superbe vain -

T.B.

F.B.

- queur. Le charme du foni meil le livre à ma ven - geance, Je vais per -

T.B.

F.B.

cer son in vin ci - ble cœur; Par luy, tous mes Captifs sont sortis d'escla -

T.B.

F.B.



vage; Qu'il eprouve toute ma rage -- Quel trouble me faifit! Qui me fait héfi --

Th.B. 7

F.B. 7

-ter? Quéft-ce qu'en fa fa - veur la pitié me veut di re? Frapons, Ciel! qui peut m'arrê -

Th.B. 6

F.B. 6

ter: Achevons je fremis! Vengeons nous je sou - pire! Est-ce ainfi que je

Th.B. 7

F.B. 7

## MUSIC.

Plate CXCIII.

dois me venger aujourd'hui! Ma colère se teint Quand j'approche de lui

Th.B.

F.B.

Plus je le vois plus ma vengeance est vaine; Mon bras tremblant se re-

Th.B.

F.B.

fufe à ma haine: Ah! quelle cruauté de lui ravir le jour! A ce jeune He-

Th.B.

F.B.

ros, tout cé.de sur la terre: Qui croiroit qu'il fût ne seulement pour la guerre, Il

Th.B.

F.B.

semble être fait pour l'A. Nourpuis Ne puis je me venger à moins qu'il ne pe -

Th.B.

F.B.

rille: Hé! ne suffi.t.il pas que l'Amour le pu nisse? Puisqu'il n'a pu trou -

Th.B.

F.B.

ver mes yeux as. lez charmants; Qu'il m'aime au moins par mes enchante

T.B.

F.B.

ments; Que s'il se peut, je le ha-is se

T.B.

F.B.

Translation. Intended to give such Readers as do not understand French, an idea of the Song.

At length the victim in my power I see,  
 This fatal year resigns him to my rage;  
 Subdued by sleep he lies, and leaves me free,  
 With chastening hand my fury to assuage.  
 That mighty heart invincible and fierce,  
 Which all my captives free'd from servile chains;  
 That mighty heart, my vengeful hand shall pierce,  
 My rage inventive wanton in his pains.  
 Ha in my soul what perturbation reigns!  
 What would compassion in his favour plead?  
 Strike, hand, O heaven! what charm thy force restrains?  
 Obey my wrath, I fight; yet let it bleed.  
 And is it thus my just revenge improves  
 The fair occasion to chastize my foe?  
 As I approach, a softer passion moves,  
 And all my boating fury melts in wo.  
 Trembling, relaxed, and faithless to my hate,  
 The dreadful task this coward arm declines.

How cruel thus to urge his infant fate,  
 Depriv'd of life amid his great designs!  
 In youth how blooming, what a heavenly grace,  
 Thro' all his form, resistless power displays!  
 How sweet the smile that dwells upon his face,  
 Relentless rage disarming whilst I gaze!  
 Tho' to the prowess of his conquering arms  
 Earth stood with all her hosts oppos'd in vain;  
 Yet is he form'd to spread more mild alarms,  
 And bind all nature in a softer chain.  
 Can then his blood, his precious blood, alone  
 Extinguish all the vengeance in my heart?  
 Tho' still surviving, might he not atone  
 For all the wrongs I feel, by gentler smart?  
 Since all my charms, unfeeling, he defies,  
 Let Magic force his stubborn soul subdue;  
 Whilst I, inflexible to tears and sighs,  
 With hate (if I can hate) his peace pursue.

## PART I. THEORY OF HARMONY.

## CHAP. I. Preliminary and Fundamental Experiments.

## EXPERIMENT I.

19. **W**HEN a sonorous body is struck till it gives a found, the ear, besides the principal found and its octave, perceives two other sounds very high, of which one is the twelfth above the principal found, that is to say, the octave to the fifth of that found; and the other is the seventeenth major above

the same found, that is to say, the double octave of its third major.

19. This experiment is peculiarly sensible upon the thick strings of the violoncello, of which the found being extremely low, gives to an ear, though not very much practised, an opportunity of distinguishing with sufficient ease and clearness the twelfth and seventeenth now in question (c).

21. The principal found is called the *generator* \*; \* See *Generator*. and

(c) Since the octave above the found 1 is 2, the octave below that same found shall be  $\frac{1}{2}$ ; that is to say, that the string which produces this octave shall have performed half its vibration whilst the string which produces the found 1 shall have completed one. To obtain therefore the octave above any found, the operator must multiply the quantity which expresses the found by 2; and to obtain the octave below, he must on the contrary divide the same quantity by 2.

It is for that reason that if any found whatever, for instance <i>ut</i> , is denominated	1
Its octave above will be	2
Its double octave above	4
Its triple octave above	8
In the same manner its octave below will be	$\frac{1}{2}$
Its double octave below	$\frac{1}{4}$
Its triple octave below,	$\frac{1}{8}$
And so of the rest.	
Its twelfth above	$\frac{3}{2}$
Its twelfth below	$\frac{2}{3}$
Its seventeenth major above	$\frac{5}{2}$
Its seventeenth major below	$\frac{2}{5}$

The fifth then above the found 1 being the octave beneath the twelfth, shall be, as we have immediately observed,  $\frac{3}{2}$ ; which signifies that this string performs  $\frac{3}{2}$  vibrations, that is to say one vibration and a half, during a single vibration of the string which gives the found 1.

To obtain the fourth above the found 1, we must take the twelfth below that found, and the double octave above that twelfth. In effect, the twelfth below *ut*, for instance, is *fa*, of which the double octave *fa* is the fourth above *ut*. Since then the twelfth below 1 is  $\frac{2}{3}$ , it follows that the double octave above this twelfth, that is to say, the fourth from the found 1 in ascending, will be  $\frac{2}{3}$  multiplied by 4, or  $\frac{8}{3}$ .

In short, the third major being nothing else but the double octave beneath the seventeenth, it follows, that the third major above the found 1 will be 5 divided by 4, or in other words  $\frac{5}{4}$ .

The third major of a found, for instance the third major *mi*, from the found *ut*, and its fifth *sol*, form between them a third minor *mi, sol*; now *mi* is  $\frac{3}{2}$ , and *sol*  $\frac{4}{3}$ , by what has been immediately demonstrated: from whence it follows, that the third minor, or the interval between *mi* and *sol*, shall be expressed by the relation of the fraction  $\frac{4}{3}$  to the fraction  $\frac{3}{2}$ .

To determine this relation, it is necessary to remark, that  $\frac{4}{3}$  are the same thing with  $\frac{8}{6}$ , and that  $\frac{3}{2}$  are the same thing with  $\frac{6}{4}$ : so that  $\frac{4}{3}$  shall be to  $\frac{3}{2}$  in the same relation as  $\frac{8}{6}$  to  $\frac{6}{4}$ ; that is to say, in the same relation as 10 to 12, or as 5 to 6. If, then, two sounds form between themselves a third minor, and that the first is represented by 5, the second shall be expressed by 6; or what is the same thing, if the first is represented by 1, the second shall be expressed by  $\frac{6}{5}$ .

Thus the third minor, an harmonic found which is even found in the protracted and coalescent tones of a sonorous body between the found *mi* and *sol*, an harmonic of the principal found, may be expressed by the fraction  $\frac{6}{5}$ .

*N. B.* One may see by this example, that in order to compare two sounds one with another which are expressed by fractions, it is necessary first to multiply the numerator of the fraction which expresses the first by the denominator of the fraction which expresses the second, which will give a primary number; as here the numerator 5 of the fraction  $\frac{3}{2}$ , multiplied by 2 of the fraction  $\frac{4}{3}$  has given 10. Afterwards may be multiplied the numerator of the second fraction by the denominator of the first which will give a secondary number, as here 12 is the product of 4 multiplied by 3; and the relation between these two numbers (which in the preceding example are 10 and 12), will express the relation between these sounds, or, what is the same thing, the interval which there is between the one and the other; in such a manner, that the farther the relation between these sounds departs from unity, the greater the interval will be.

Such is the manner in which we may compare two sounds one with another whose numerical value is known. We shall now show the manner how the numerical expression of a found may be obtained, when the relation which it ought to have with another found is known whose numerical expression is given.

Let

Theory of Harmony.

and the two other sounds which it produces, and with which it is accompanied, are, inclusive of its octave, called its harmonics §.

69 Generator what. § See Harmonic.

EXPERIMENT II.

22. There is no person insensible of the resemblance which subsists between any found and its octave, whether above or below. These two sounds, when heard together, almost entirely coalesce in the organ of sensation. We may besides be convinced (by two facts which are extremely simple) of the facility with which one of these sounds may be taken for the other.

Let it be supposed that any person has an inclination to sing a tune, and having at first begun this air upon a pitch too high or too low for his voice, so that he is obliged, lest he should strain himself too much, to sing the tune in question on a key higher or lower than the first; I affirm, that, without being initiated in the art of music, he will naturally take his new key in the octave below or the octave above the first; and that in order to take this key in any other interval except the octave, he will find it necessary to exert a sensible degree of attention. This is a fact of which we may easily be persuaded by experience.

Another fact. Let any person sing a tune in our presence, and let it be sung in a tone too high or too low for our voice; if we wish to join in singing this air, we naturally take the octave below or above, and frequently, in taking this octave, we imagine it to be the unison (v).

CHAP. II. The Origin of the Modes Major and Minor; of the most natural Modulation, and the most perfect Harmony.

23. To render our ideas still more precise and permanent, we shall call the tone produced by the sonorous body *ut*; it is evident, by the first experiment, that this sound is always attended by its 12th and 17th major; that is to say, with the octave of *sol*, and the double octave of *mi*.

24. This octave of *sol* then, and this double octave of *mi*, produce the most perfect chord which can be joined with *ut*, since that chord is the work and choice

of nature (ε).

25. For the same reason, the modulation formed by *ut* with the octave of *sol* and the double octave of *mi*, sung one after the other, would likewise be the most simple and natural of all modulations which do not descend or ascend directly in the diatonic order, if our voices had sufficient compass to form intervals so great without difficulty: but the ease and freedom with which we can substitute its octave to any found, when it is more convenient for the voice, afford us the means of representing this modulation.

26. It is on this account that, after having sung *Mode major*, the tone *ut*, we naturally modulate the third *mi*, and the fifth *sol*, instead of the double octave of *mi*, and the octave of *sol*; from whence we form, by joining the octave of the found *ut*, this modulation, *ut, mi, sol, ut*, which in effect is the simplest and easiest of them all; and which likewise has its origin even in the protracted and compounded tones produced by a sonorous body.

27. The modulation *ut, mi, sol, ut*, in which the chord *ut, mi*, is a third major, constitutes that kind of harmony or melody which we call the *mode major*; from whence it follows, that this mode results from the immediate operation of nature.

28. In the modulation *ut, mi, sol*, of which we have now been treating, the sounds *mi* and *sol* are proportioned one to the other, that the principal found *ut* (art. 19.) causes both of them to resound; but the second tone *mi* does not cause *sol* to resound, which only forms the interval of a third minor.

29. Let us then imagine, that, instead of this found *mi*, one should substitute between the sounds *ut sol* another note which (as well as the found *ut*) has the power of causing *sol* to resound, and which is, however, different from the found *ut*; the sound which we explore ought to be such, by art. 19. that it may have for its 17th major *sol*, or one of the octaves of *sol*; of consequence the found which we seek ought to be a 17th major below *sol*, or, what is the same thing, a third major below the same *sol*. Now the found *mi* being a third minor beneath *sol*, and the third major being (art. 9.) greater by a semitone than the third minor, it follows, that the found of which we are

Let us suppose, for example, that the third major of the fifth  $\frac{1}{2}$  is sought. That third major ought to be, by what has been shown above, the  $\frac{2}{3}$  of the fifth; for the third major of any found whatever is the  $\frac{2}{3}$  of that found. We must then look for a fraction which expresses the  $\frac{2}{3}$  of  $\frac{1}{2}$ ; which is done by multiplying the numerators and denominators of both fractions one by the other, from whence results the new fraction  $\frac{1}{3}$ . It will likewise be found that the fifth of the fifth is  $\frac{2}{3}$ , because the fifth of the fifth is the  $\frac{1}{2}$  of  $\frac{1}{2}$ .

Thus far we have only treated of fifths, fourths, thirds major and minor, in ascending; now it is extremely easy to find by the same rules the fifths, fourths, thirds major and minor in descending. For suppose *ut* equal to 1, we have seen that its fifth, its fourth, its third, its major and minor in ascending, are  $\frac{1}{2}$ ,  $\frac{2}{3}$ ,  $\frac{3}{4}$ ,  $\frac{4}{5}$ . To find its fifth, its fourth, its third major and minor in descending, nothing more is necessary than to reverse these fractions, which will give  $\frac{2}{1}$ ,  $\frac{3}{2}$ ,  $\frac{4}{3}$ ,  $\frac{5}{4}$ .

(D) It is not then imagined that we change the value of a found in multiplying or dividing it by 2, by 4, or by 8, &c. the number which expresses these sounds, since by these operations we do nothing but take the simple, double, or triple octave, &c. of the found in question, and that a found coalesces with its octave.

(E) The chord formed with the twelfth and seventeenth major united with the principal found, being exactly conformed to that which is produced by nature, is likewise for that reason the most agreeable of all; especially when the composer can proportion the voices and instruments together in a proper manner to give this chord its full effect. M. Rameau has executed this with the greatest success in the opera of *Pygmalion*, page 34. where Pygmalion sings with the chorus, *L'amour triomphe*, &c.: in this passage of the chorus, the two parts of the vocal and instrumental bass gives the principal found and its octave; the first part above, or treble, and that of the counter-tenor, produce the seventeenth major, and its octave, in descending; and in short, the second part, or tenor above, gives the twelfth.

Theory of Harmony.

71 Harmony reduced to chords, fifths, and octaves.

72 Mode major, what.

See Mode major; likewise Interval.

73 Mode minor, what.

70 Fundamental and harmonics, what.

Theory of Harmony. are in search shall be a semitone beneath the natural *mi*, and of consequence *mi ♭*.

there may be some fundamental bases by thirds, deduced from the two seventeenth, of which the one is an attendant of the principal found, and of which the other includes that found. But we must advance step by step, and satisfy ourselves at present to consider immediately the fundamental bases by fifths.

Theory of Harmony.

74  
origin of mode minor.  
See mode. See to Interval.

75  
perfect chords, hat.

76  
fundamental basis heard, hat.

77  
Exception to the rule.

78  
Two perfect chords in succession prohibited.

79  
Mode in general, what.

80  
Modes, how represented by the series of fifths.

See Fig. C.

30. This new arrangement, *ut, mi ♭, sol*, in which the sounds *ut* and *mi ♭* have both the power of causing *sol* to resound, though *ut* does not cause *mi ♭* to resound, is not indeed equally perfect with the first arrangement *ut, mi, sol*; because in this the two sounds *mi* and *sol* are both the one and the other generated by the principal found *ut*; whereas, in the other, the found *mi ♭* is not generated by the found *ut*; but this arrangement *ut, mi ♭, sol*, is likewise dictated by nature (art. 19.), though less immediately than the former; and accordingly experience evinces that the ear accommodates itself almost as well to the latter as to the former.

31. In this modulation or chord *ut, mi ♭, sol, ut*, it is evident that the third from *ut* to *mi ♭* is minor; and such is the origin of that mode which we call *minor* (F).

32. The most perfect chords then are, 1. All chords related one to another, as *ut, mi, sol, ut*, consisting of any found of its third major, of its fifth, and of its octave. 2. All chords related one to another, as *ut, mi ♭, sol, ut*, consisting of any found, of its third minor, of its fifth, and of its octave. In effect, these two kinds of chords are exhibited by nature; but the first more immediately than the second. The first are called *perfect chords major*, the second *perfect chords minor*.

CHAP. III. Of the Series which the Fifth requires, and of the Laws which it observes.

33. SINCE the found *ut* causes the found *sol* to be heard, and is itself heard in the found *fa*, which sounds *sol* and *fa* are its two-twelfths, we may imagine a modulation composed of that found *ut* and its two-twelfths, or, which is the same thing (art. 22.), of its two-fifths, *fa* and *sol*, the one below, the other above; which gives the modulation or series of fifths *fa, ut, sol*, which I call the *fundamental basis* of *ut* by fifths.

We shall find in the sequel (Chap. XVIII.) that

34. Thus, from the found *ut*, one may make a transition indifferently to the found *sol*, or to the found *fa*.

35. One may, for the same reason, continue this kind of fifths in ascending, and in descending, from *ut*, in this manner:

*mi ♭, f ♭, fa, ut, sol, re, la, &c.*

And from this series of fifths one may pass to any found which immediately precedes or follows it.

36. But it is not allowed in the same manner to pass from one found to another which is not immediately contiguous to it; for instance, from *ut* to *re*, or from *re* to *ut*: for this very simple reason, that the found *re* is not contained in the found *ut*, nor the found *ut* in that of *re*; and thus these sounds have not any alliance the one with the other, which may authorize the transition from one to the other.

37. And as these sounds *ut* and *re*, by the first experiment, naturally bring along with them the perfect chords consisting of greater intervals *ut, mi, sol, ut, re, fa, la, re*; hence may be deduced this rule, That two perfect chords, especially if they are major (G), cannot succeed one another diatonically in a fundamental basis; we mean, that in a fundamental basis two sounds cannot be diatonically placed in succession, each of which, with its harmonics, forms a perfect chord, especially if this perfect chord be major in both.

CHAP. IV. Of Modes in general.

38. A mode, in music, is nothing else but the order of sounds prescribed, as well in harmony as melody, by the series of fifths. Thus the three sounds *fa, ut, sol*, and the harmonics of each of these three sounds, that is to say, their thirds major and their fifths, compose all the major modes which are proper to *ut*.

39. The series of fifths then, or the fundamental basis *fa, ut, sol*, of which *ut* holds the middle space,

(F) The origin which we have here given of the mode minor, is the most simple and natural that can possibly be given. In the first edition of this treatise, I had followed M. Rameau in deducing it from the following experiment.—If you put in vibration a musical string AB, and if there are at the same time contiguous to this two other strings CF, LM, of which the first shall be a twelfth below the string AB, and the second LM a seventeenth major below the same AB, the strings CF, LM, will vibrate without being struck as soon as the string AB shall give a sound, and divide themselves by a kind of undulation, the first into three, the last into five equal parts; in such a manner, that, in the vibration of the string CF, you may easily distinguish two points at rest D, E, and in the tremulous motion of the string LM four acquiescent points N, O, P, Q, all placed at equal distances from each other, and dividing the strings into three or five equal parts. In this experiment, says M. Rameau, if we represent by *ut* the tone of the string AB, the two other strings will represent the sounds *fa* and *la ♭*; and from thence M. Rameau deduces the modulation *fa, la ♭, ut*, and of consequence the mode minor. The origin which we have assigned to the minor mode in this new edition, appears to me more direct and more simple, because it pre-supposes no other experiment than that of art. 19. and because also the fundamental found *ut* is still retained in both the modes, without being obliged, as M. Rameau found himself, to change it into *fa*.

(G) I say especially if they are major; for in the major chord *re, fa, la, re*, besides that the sounds *ut* and *re* have no common harmonical relation, and are even distant between themselves (Art. 18.), it will likewise be found, that *fa* forms a dissonance with *ut*. The minor chord *re, fa, la, re*, would be more tolerable, because the natural *fa* which occurs in this chord carries along with it its fifth *ut*, or rather the octave of that fifth: It has likewise been sometimes the practice of composers, though rather by a licence indulged them than strictly agreeable to their art, to place a minor in diatonic succession to a major chord.

Theory of Harmony.

Theory of Harmony.

may be regarded as representing the mode of *ut*. One may likewise take the series of fifths, or fundamental base, *ut, sol, re*, as representing the mode of *sol*; in the same manner *fi, fa, ut*, will represent the mode of *fa*.

By this we may see, that the mode of *sol*, or rather the fundamental base of that mode, has two founds in common with the fundamental base of the mode of *ut*. It is the same with the fundamental base of the mode

ear which has been immediately affected with the principal mode feels always a strong propensity to return to it. Thus the further the mode to which we make a transition is removed from the principal mode, the less time we ought to dwell upon it; or rather, to speak in the terms of the art, the less ought the phrase ( $\frac{1}{2}aa$ ) of that mode to be protracted.

CHAP. V. Of the Formation of the Diatonic Scale as used by the Greeks.

81 Principal mode, and adjuncts, what. See Adjunct.

81 *fa*. 40. The mode of *ut* (*fa, ut, sol*,) is called the principal mode with respect to the modes of these two fifths, which are called its two adjuncts.

82 Modes related in proportion as their founds are common.

41. It is then, in some measure, indifferent to the ear whether a transition be made to the one or to the other of these adjuncts, since each of them has equally two founds in common with the principal mode. Yet the mode of *sol* seems a little more eligible: for *sol* is heard amongst the harmonics of *ut*, and of consequence is implied and signified by *ut*; whereas *ut* does not cause *fa* to be heard, though *ut* is included in the same found *fa*. It is hence that the ear, affected by the mode of *ut*, is a little more prepossessed for the mode of *sol* than for that of *fa*. Nothing likewise is more frequent, nor more natural, than to pass from the mode of *ut* to that of *sol*.

83 Dominant and sub-dominant, what. See Dominant.

42. It is for this reason, as well as to distinguish the two fifths one from the other, that we call *sol* the fifth above the generator the dominant found, and the fifth *fa* beneath the generator the subdominant.

84 Transition to contiguous founds, how to be managed.

43. It remains to add, as we have seen in the preceding chapter, that, in the series of fifths, we may indifferently pass from one found to that which is contiguous: In the same manner, and for the same reason, one may pass from the mode of *sol* to the mode of *re*, after having made a transition from the mode of *ut* to the mode of *sol*, as from the mode of *fa* to the mode of *fi*. But it is necessary, however, to observe, that the

44. FROM this rule, that two founds which are contiguous may be placed in immediate succession in the series of fifths, *fa, ut, sol*, it follows, that one may form this modulation, or this fundamental base, by fifths, *sol, ut, sol, ut, fa, ut, fa*.

45. Each of the founds which forms this modulation brings necessarily along with itself its third major, its fifth, and its octave; inasmuch that he who, for the instance, sings the note *sol* may be reckoned to sing at the same time the notes *sol, fi, re, sol*: in the same manner the found *ut* in the fundamental base brings along with it this modulation, *ut, mi, sol, ut*; and, in short, the same found *fa* brings along with it *fa, la, ut, fa*. This modulation then, or this fundamental base,

See fig. D. Formation of the Greek diatonic scale by the fundamental base.

gives the following diatonic series, *fi, ut, re, mi, fa, sol, la*.

which is precisely the diatonic scale of the Greeks. We are ignorant upon what principles they had formed this scale; but it may be sensibly perceived, that that series arises from the base *sol, ut, sol, ut, fa, ut, fa*; and that of consequence this base is justly called fundamental, as being the real primitive modulation, that which conducts the ear, and which it feels to be implied in the diatonic modulation *fi, ut, re, mi, fa, sol, la*, (H).

46. We shall be still more convinced of this truth by the following remarks.

In the modulation *fi, ut, re, mi, fa, sol, la*, the founds

( $\frac{1}{2}aa$ ) As the mere English reader, unacquainted with the technical phraseology of music, may be surpris'd at the use of the word *phrase* when transferred from language to that art, we have thought proper to insert the definition of Rousseau.

A *phrase*, according to him, is in melody a series of modulations, or in harmony a succession of chords, which form without interruption a sense more or less complete, and which terminate in a repose by a cadence more or less perfect.

(H) Nothing is easier than to find in this scale the value or proportions of each found with relation to the found *ut*, which we call 1; for the two founds *sol* and *fa* in the base are  $\frac{1}{2}$  and  $\frac{2}{3}$ ; from whence it follows,

1. That *ut* in the scale is the octave of *ut* in the base; that is to say, 2.
2. That *fi* is the third major of *sol*; that is to say  $\frac{5}{4}$  of  $\frac{1}{2}$  (note c), and of consequence  $\frac{5}{8}$ .
3. That *re* is the fifth of *sol*; that is to say  $\frac{3}{2}$  of  $\frac{1}{2}$ , and of consequence  $\frac{3}{4}$ .
4. That *mi* is the third major of the octave of *ut*, and of consequence the double of  $\frac{5}{8}$ ; that is to say,  $\frac{5}{4}$ .
5. That *fa* is the double octave of *fa* of the base, and consequently  $\frac{8}{3}$ .
6. That *sol* of the scale is the octave of *sol* of the base, and consequently 3.
7. In short, that *la* in the scale is the third major of *fa* of the scale; that is to say,  $\frac{5}{3}$  of  $\frac{8}{3}$ , or  $\frac{10}{3}$ .

Hence then will result the following table, in which each found has its numerical value above or below it.

$$\begin{array}{l} \text{Diatonic} \\ \text{Scale.} \end{array} \left\{ \begin{array}{l} \frac{1}{2} \\ \frac{5}{8} \\ 2 \\ \frac{3}{4} \\ \frac{5}{4} \\ \frac{3}{2} \\ \frac{8}{3} \\ 3 \\ \frac{10}{3} \end{array} \right.$$

$$\begin{array}{l} \text{Fundamental} \\ \text{Base.} \end{array} \left\{ \begin{array}{l} \text{sol, ut, sol, ut, fa, ut, fa.} \\ 1, \frac{1}{2}, 1, \frac{1}{2}, 1, \frac{1}{2}, 1, \frac{1}{2} \end{array} \right.$$

And if, for the conveniency of calculation, we choose to call the found *ut*, of the scale 1; in this case there is nothing to do but to divide each of the numbers by 2, which represent the diatonic scale, and we shall have

$$\frac{1}{2}, 1, \frac{5}{8}, \frac{3}{4}, \frac{5}{4}, \frac{3}{2}, \frac{8}{3}, \frac{10}{3}$$

*fi, ut, re, mi, fa, sol, la.*



Theory of Harmony. founds *re* and *fa* form between themselves a third minor, which is not perfectly true as that between *mi* and *sol* (1). Nevertheless this alteration in the third minor between *re* and *fa* gives the ear no pain, because that *re* and that *fa*, which do not form between themselves a true third minor, form, each in particular, consonances perfectly just with the founds in the fundamental bass which correspond with them: for *re* in the scale is the true fifth of *sol*, which answers to it in the fundamental bass; and *fa* in the scale is the true octave of *fa*, which answers to it in the same bass.

85 Altered intervals, no objection. 47. If, therefore, these founds in the scale form consonances perfectly true with the notes which correspond to them in the fundamental bass, the ear gives itself little trouble to investigate the alterations which there may be in the intervals which these founds in the scale form between themselves. This is a new proof that the fundamental bass is the genuine guide of the ear, and the true origin of the diatonic scale.

86 Reasons why this scale includes only seven founds. 48. Moreover, this diatonic scale includes only seven founds, and goes no higher than *si*, which would be the octave of the first: a new singularity, for which a reason may be given by the principles above established. In reality, in order that the found *si* may succeed immediately in the scale to the found *la*, it is necessary that the note *sol*, which is the only one from whence *si* as a harmonic may be deduced, should immediately succeed to the found *fa*, in the fundamental bass, which is the only one from whence *la* can be harmonically deduced. Now, the diatonic succession from *fa* to *sol* cannot be admitted in the fundamental bass, according to what we have remarked (art. 36.) The founds *la* and *si*, then, cannot immediately succeed one another in the scale: we shall see in the sequel why this is not the case in the series *ut, re, mi, fa, sol, la, si, UT*, which begins upon *ut*; whereas the scale in question here begins upon *si*.

87 Completion of the Greek octave. 49. The Greeks likewise, to form an entire octave, added below the first *si* the note *la*, which they distinguished and separated from the rest of the scale,

and which for that reason they called *proslambano-mene*, that is to say, a string or note subadded to the scale, and put before *si* to form the entire octave.

50. The diatonic scale *si, ut, re, mi, fa, sol, la, si* is composed of two tetrachords, that is to say, of two diatonic scales, each consisting of four founds, *si, ut, re, mi*, and *mi, fa, sol, la*. These two tetrachords are exactly similar; for from *mi* to *fa* there is the same interval as from *si* to *ut*; from *fa* to *sol* the same as from *ut* to *re*, from *sol* to *la* the same as from *re* to *mi* (L): this is the reason why the Greeks distinguished these two tetrachords; yet they joined them by the note *mi*, which is common to both, and which gave them the name of *conjunctive tetrachords*.

51. Moreover, the intervals between any two founds, taken in each tetrachord in particular, are precisely true: thus, in the first tetrachord, the intervals of *ut mi*, and *si re*, are thirds, the one major and the other minor, exactly true, as well as the fourth *si mi* (M); it is the same thing with the tetrachord *mi, fa, sol, la*, since this tetrachord is exactly like the former.

52. But the case is not the same when we compare two founds taken each from a different tetrachord; for we have already seen, that the note *re* in the first tetrachord forms with the note *fa* in the second a third minor, which is not true. In like manner it will be found, that the fifth from *re* to *la* is not exactly true, which is evident; for the third major from *fa* to *la* is true, and the third minor from *re* to *fa* is not so: now, in order to form a true fifth, a third major and a third minor, which are both exactly true, are necessary.

53. From thence it follows, that every consonance is absolutely perfect in each tetrachord taken by itself; but that there is some alteration in passing from one tetrachord to the other. This is a new reason for distinguishing the scale into these two tetrachords.

54. It may be ascertained by calculation, that in the tetrachord *si, ut, re, mi*, the interval, or the tone

[ d ]

(1) In order to compare *re* with *fa*, we need only compare  $\frac{3}{4}$  with  $\frac{2}{3}$ ; the relation between these fractions will be (Note c), that of 9 times 3 to 8 times 4; that is to say, of 27 to 32: the third minor, then, from *re* to *fa*, is not true; because the proportion of 27 to 32 is not the same with that of 5 to 6, these two proportions being between themselves as 27 times 6 is to 32 times 5, that is to say, as 162 to 160, or as the halves of these two numbers, that is to say, as 81 to 80.

M. Rameau, when he published, in 1726, his *New theoretical and practical System of Music*, had not as yet found the true reason of the alteration in the consonance which is between *re* and *fa*, and of the little attention which the ear pays to it. For he pretends, in the work now quoted, that there are two thirds minor, one in the proportion of 5 to 6, the other in the proportion of 27 to 32. But the opinion which he has afterwards adopted, seems much preferable. In reality, the genuine third minor, is that which is produced by nature between *mi* and *sol*, in the continued tone of those sonorous bodies, of which *mi* and *sol* are the two harmonics; and that third minor, which is in the proportion of 5 to 6, is likewise that which takes place in the minor mode, and not that third minor which is false and different, being in the proportion of 27 to 32.

(L) The proportion of *si* to *ut* is as  $\frac{7}{8}$  to 1, that is to say as 15 to 16; that between *mi* and *fa* is as  $\frac{3}{4}$  to  $\frac{2}{3}$  that is to say (note c) as 5 times 3 to 4 times 4, or as 15 to 16: these two proportions then are equal. In the same manner, the proportion of *ut* to *re* is as 1 to  $\frac{3}{4}$ , or as 8 to 9; that between *fa* and *sol* is as  $\frac{4}{5}$  to  $\frac{3}{4}$ ; that is to say (note c), as 8 to 9. The proportion of *mi* to *ut* is as  $\frac{5}{6}$  to 1, or as 5 to 4; that between *fa* and *la* is as  $\frac{5}{4}$  to  $\frac{4}{3}$ , or as 5 to 4: the proportions here then are likewise equal.

(M) The proportion of *mi* to *ut* is as  $\frac{1}{2}$  to 1, or as 5 to 4, which is a true third major; that from *re* to *si* is as  $\frac{1}{3}$  to  $\frac{2}{3}$ ; that is to say, as 9 times 1 to 15 times 8, or as 9 times 2 to 15, or as 6 to 5. In like manner, we shall find, that the proportion of *mi* to *si* is as  $\frac{2}{3}$  to  $\frac{1}{2}$ ; that is to say, as 5 times 16 to 15 times 4, or as 4 to 3, which is a true fourth.

Theory of Harmony.

from *re* to *mi*, is a little less than the interval or tone from *ut* to *re* (8). In the same manner, in the second tetrachord *mi, fa, sol, la*, which is, as we have proved, perfectly similar to the first, the note from *sol* to *la* is a little less than the note from *fa* to *sol*. It is for this reason that they distinguish two kinds of tones; the greater tone \*, as from *ut* to *re*, from *fa* to *sol*, &c.; and the lesser †, as from *re* to *mi*, from *sol* to *la*, &c.

\* Greater tone. See Interval. † Lesser tone. See Interval.

CHAP. VI. The formation of the Diatonic Scale among the Moderns, or the ordinary Gammut.

93 The modern scale, how formed.

55. WE have just shown in the preceding chapter, how the scale of the Greeks is formed, *fa, ut, re, mi, fa, sol, la*, by means of a fundamental bass composed of three sounds only, *fa, ut, sol*: but to form the scale *ut, re, mi, fa, sol, la, si, UT*, which we use at present, we must necessarily add to the fundamental bass the note *re*, and form, with these four sounds *fa, ut, sol, re*, the following fundamental bass:

See fig. E. See Scale.

*ut, sol, ut, fa, ut, sol, re, re, sol, ut*  
from whence we deduce the modulation or scale.  
*ut, re, mi, fa, sol, la, si, UT.*

In effect (o), *ut* in the scale belongs to the harmony of *ut* which corresponds with it in the bass; *re*, which is the second note in the gammut, is included in the harmony of *sol*, the second note of the bass; *mi*, the third note of the gammut, is a natural harmonic of *ut*, which is the third found in the bass, &c.

94 The Greek diatonic scale simpler than ours, and why.

56. From thence it follows, that the diatonic scale of the Greeks is, at least in some respects, more simple than ours; since the scale of the Greeks (chap. v.) may be formed alone from the mode proper to *ut*; whereas ours is originally and primitively formed, not only from the mode of *ut* (*fa, ut, sol*), but likewise from the mode of *sol*, (*ut, sol, re*).

It will likewise appear, that this last scale consists of two parts; of which the one, *ut, re, mi, fa, sol*, is in the mode of *ut*; and the other, *sol, la, si, ut*, in that of *sol*.

95 The note sol twice repeated in the diatonic scale from its harmonic relations to the fundamental bass.

57. It is for this reason that the note *sol* is found to be twice repeated in immediate succession in this scale; once as the fifth of *ut*, which corresponds with it in the fundamental bass; and again, as the octave of *sol*, which immediately follows *ut* in the same bass. As

(n) The proportion of *re* to *ut* is as  $\frac{9}{8}$  to 1, or as 9 to 8; that of *mi* to *re* is as  $\frac{5}{4}$  to  $\frac{9}{8}$ , that is to say, as 40 to 36, or as 10 to 9: now  $\frac{10}{9}$  is less from unity than  $\frac{9}{8}$ ; the interval then from *re* to *mi* is a little less than that from *ut* to *re*.

If any one would wish to know the proportion which  $\frac{10}{9}$  bear to  $\frac{9}{8}$ , he will find (note c), that it is as 8 times 10 to 9 times 9, that is to say, as 80 to 81. Thus the proportion of a minor to a major tone is as 80 to 81; this difference between the major and minor tone, is what the Greeks called a *comma*. Though real, it is imperceptible to the ear.

We may remark, that this difference of a comma is found between the third minor when true and harmonical, and the same chord when it suffers alteration *re fa*, of which we have taken notice in the scale (note 1); for we have seen, that this third minor thus altered is in the proportion of 80 to 81 with the true third minor.

(o) The values or estimates of the notes shall be the same in this as in the former scale, excepting only the tone *la*; for *re* being represented by  $\frac{9}{8}$ , its fifth shall be expressed by  $\frac{3}{2}$ ; so that the scale will be numerically signified thus:

$$1 \quad \frac{9}{8} \quad \frac{5}{4} \quad \frac{4}{3} \quad \frac{3}{2} \quad \frac{7}{4} \quad \frac{15}{8} \quad 2$$

*ut, re, mi, fa, sol, la, si, UT.*

Where you may see, that the note *la* of this scale is different from that in the scale of the Greeks; and that the *la* in the modern series stands in proportion to that of the Greeks as  $\frac{3}{2}$  to  $\frac{5}{4}$ , that is to say, as 81 to 80; these two *la*'s then likewise differ by a *comma*.

to what remains, these two consecutive *sol*'s are otherwise in perfect unison. It is for this reason that we are satisfied with singing only one of them when one modulates the scale *ut, re, mi, fa, sol, la, si, UT*: but this does not prevent us from employing a *pause* or *repose*, expressed or understood, after the found *fa*. There is no person who does not perceive this whilst he himself sings the scale.

Theory of Harmony.

58. The scale of the moderns, then, may be considered as consisting of two tetrachords, disjunctive indeed, but perfectly similar one to the other, *ut, re, mi, fa*, and *sol, la, si, ut*, one in the mode of *ut*, the other in that of *sol*. For what remains, we shall see in the sequel by what artifice one may cause the scale, *ut, re, mi, fa, sol, la, si, UT*, to be regarded as belonging to the mode of *ut* alone. For this purpose it is necessary to make some changes in the fundamental bass, which we have already assigned: but this shall be explained at large in chap. xiii.

96 The modern scale composed of two disjunctive tetrachords of different modes.

59. The introduction of the mode proper to *sol* in the fundamental bass has this happy effect, that the notes *fa, sol, la, si*, may immediately succeed each other in ascending the scale, which cannot take place (art. 48.) in the diatonic series of the Greeks, because that series is formed from the mode of *ut* alone. From whence it follows:

97 The mode of sol introduced in the fundamental bass productive of conveniences.

1. That we change the mode at every time when we modulate three notes in succession.

2. That if these three notes are sung in succession in the scale *ut, re, mi, fa, sol, la, si, UT*, this cannot be done but by the assistance of a *pause* expressed or understood after the note *fa*; inasmuch, that the three tones *fa, sol, la, si*, (three only because the note *sol* which is repeated is not enumerated) are supposed to belong to two different tetrachords.

60. It ought not then any longer to surprise us that we feel some difficulty whilst we ascend the scale in singing three tones in succession, because this is impracticable without changing the mode; and if one pauses in the same mode, the fourth found above the first note will never be higher than a semitone above that which immediately precedes it; as may be seen by *ut, re, mi, fa*, and by *sol, la, si, ut*, where there is no more than a semitone between *mi* and *fa*, and between *si* and *ut*.

99 Change of mode the cause of the difficulty in singing three consecutive tones ascending.

Theory of  
Harmony.Theory of  
Harmony.Intervals,  
though altered  
in themselves,  
form true consonances  
with the fundamen-  
tal bass.Fewer al-  
tered conso-  
nances in the  
Greek scale than  
in ours.TO  
Tempera-  
ment,  
why neces-  
sary.

61. We may likewise observe in the scale *ut, re, mi, fa*, that the third minor from *re* to *fa* is not true, for the reasons which have been already given (art 49.) It is the same case with the third minor from *la* to *ut*, and with the third major from *fa* to *la*; but each of these founds form otherwise consonances perfectly true, with their correspondent founds in the fundamental bass.

62. The thirds *la ut, fa la*, which were true in the former scale, are false in this; because in the former scale *la* was the third of *fa*, and here it is the fifth of *re*, which corresponds with it in the fundamental bass.

63. Thus it appears, that the scale of the Greeks contains fewer consonances that are altered than ours (*p*); and this likewise happens from the introduction of the mode of *sol* into the fundamental bass (*Q*).

We see likewise that the value of *la* in the diatonic scale, a value which authors have been divided in ascertaining, solely depends upon the fundamental bass, and that it must be different according as the note *la* has *fa* or *re* for its bass. See the note (*o*).

#### CHAP. VII. Of Temperament.

64. THE alterations which we have observed in the intervals between particular founds of the diatonic scale, naturally lead us to speak of temperament. To give a clear idea of this, and to render the necessity of it palpable, let us suppose that we have before us an instrument with keys, a harpsichord, for instance, consisting of several octaves or scales, of which each includes its twelve semitones.

(*p*) In the scale of the Greeks, the note *la* being a third from *fa*, there is an altered fifth between *la* and *re*: but in ours, *la* being a fifth to *re*, produces two altered thirds, *fa la*, and *la ut*; and likewise a fifth altered, *la mi*, as we shall see in the following chapter. Thus there are in our scale two intervals more than in the scale of the Greeks which suffer alteration.

(*Q*) But here it may be with some colour objected. The scale of the Greeks, it may be said, has a fundamental bass more simple than ours; and besides, in it there are fewer chords which will not be found exactly true: why then, notwithstanding this, does ours appear more easy to be sung than that of the Greeks? The Grecian scale begins with a semitone, whereas the intonation prompted by nature seems to impel us to rise by a full tone at once. This objection may be thus answered. The scale of the Greeks is indeed better disposed than ours for the simplicity of the bass, but the arrangement of ours is more suitable to natural intonation. Our scale commences by the fundamental found *ut*, and it is in reality from that found that we ought to begin; it is from this that all the others naturally arise, and upon this that they depend; nay, if I may speak so, in this they are included: on the contrary, neither the scale of the Greeks, nor its fundamental bass, commences with *ut*; but it is from this *ut* that we must depart, in order to regulate our intonation, whether in rising or descending: now, in ascending from *ut*, the intonation, even of the Greek scale, gives the series *ut, re, mi, fa, sol, la*: and so true is it that the fundamental found *ut* is here the genuine guide of the ear, that if, before we modulate the found *ut*, we should attempt to rise to it by that note in the scale which is most immediately contiguous, we cannot reach it but by the note *fa*, and by the semitone from *fa* to *ut*. Now to make a transition from *fa* to *ut* by this semitone, the ear must of necessity be predisposed for that modulation, and consequently preoccupied with the mode of *ut*: if this were not the case, we should naturally rise from *fa* to *ut*%, and by this operation pass into another mode.

(*R*) The LA considered as the fifth of *re* is  $\frac{3}{2}$ , and the fourth beneath this LA will constitute  $\frac{1}{2}$  of  $\frac{3}{2}$ , that is to say,  $\frac{9}{8}$ ;  $\frac{9}{8}$ :  $\frac{8}{8}$  then shall be the value of *mi*, considered as a true fourth from LA in descending: now *mi*, considered as the third major of the found UT, is  $\frac{5}{4}$ , or  $\frac{5}{4}$ : these two *mi*'s then are between themselves in the proportion of 81 to 80; thus it is impossible that *mi* should be at the same time a perfect third major from UT, and a true fourth beneath LA.

(*s*) In effect, if you thus alternately tune the fifth above, and the fourth below, in the same octave, you may here see what will be the process of your operation.

UT, SOL, a fifth; *re* a fourth; LA a fifth; *mi* a fourth; *fa* a fifth; *ut*% a fifth; *sol*% a fourth; RE% a fifth; *la*% a fourth; MI% or FA a fifth; *li*% a fourth: now it will be found, by a very easy computation, that the first UT being represented by 1, SOL shall be  $\frac{1}{2}$ , *re*  $\frac{2}{3}$ , LA  $\frac{1}{2}$ , *mi*  $\frac{3}{4}$ , &c. and so of the

Let us choose in that harpsichord one of the strings which will found the note UT, and let us tune the string SOL to a perfect fifth with UT in ascending; let us afterwards tune to a perfect fifth with this SOL the RE which is above it; we shall evidently perceive that this RE will be in the scale above that from which we set out: but it is also evident that this RE must have in the scale a *re* which corresponds with it, and which must be tuned a true octave below RE; and between this and SOL there should be the interval of a fifth; so that the *re* in the first scale will be a true fourth below the SOL of the same scale. We may afterwards tune the note LA of the first scale to a just fifth with this last *re*; then the note MI in the highest scale to a true fifth with this new LA, and of consequence the *mi* in the first scale to a true fourth beneath this same LA: Having finished this operation, it will be found that the last *mi*, thus tuned, will by no means form a just third major from the found UT (*r*): that is to say, that it is impossible for *mi* to constitute at the same time the third major of UT, and the true fifth of LA; or, what is the same thing, the true fourth of LA in descending.

65. What is still more, if, after having successively and alternately tuned the strings UT, SOL, *re*, LA, *mi*, in perfect fifths and fourths one from the other, we continue to tune successively by true fifths and fourths the strings *mi, fa, ut*%, *sol*%, *re*%, *mi*%, *fa*%; we shall find, that, though *fa*%, being a semitone higher than the natural note, should be equivalent to UT natural, it will by no means form a just octave to the first *ut* in the scale, but be considerably higher (*s*);

( d 2 )

yet

Theory of Harmony.

yet this *fi* upon the harpsichord ought not to be different from the octave above UT; for every *fi* and every UT is the same found, since the octave or the scale only consists of twelve semitones.

102 Relations and rules for temperament.

66. From thence it necessarily follows, 1. That it is impossible that all the octaves and all the fifths should be just at the same time, particularly in instruments which have keys, where no intervals less than a semitone are admitted. 2. That, of consequence, if the fifths are justly tuned, some alteration must be made in the octaves; now the sympathy of found which subsists between any note and its octave, does not permit us to make such an alteration: this perfect coalescence of found is the cause why the octave should serve as limits to the other intervals, and that all the notes which rise above or fall below the ordinary scale, are no more than replications, *i. e.* repetitions, of all that have gone before them. For this reason, if the octave were altered, there could be no longer any fixed point either in harmony or melody. It is then absolutely necessary to tune the *ut* or *fi* in a just octave with the first; from whence it follows, that, in the progression of fifths, or, what is the same thing, in the alternate series of fifths and fourths, UT, SOL, *re*, LA, *mi*, *fi*, *fa*%, *ut*%, *sol*%, *re*%, *la*%, *mi*%, *fi*%, it is necessary that all the fifths should be altered, or at least some of them. Now, since there is no reason why one should rather be altered than another, it follows, that we ought to alter them all equally. By these means, as the alteration is made to influence all the fifths, it will be in each of them almost impercep-

tible; and thus the fifth, which, after the octave, is the most perfect of all consonances, and which we are under a necessity of altering, must only be altered in the least degree possible.

Theory of Harmony.

67. It is true, that the thirds will be a little harsh; but as the interval of sounds which constitutes the third, produces a less perfect coalescence than that of the fifth, it is necessary, says M. Rameau, to sacrifice the justice of that chord to the perfection of the fifth; for the more perfect a chord is in its own nature, the more displeasing to the ear is any alteration which can be made in it. In the octave the least alteration is insupportable.

68. This change in the intervals of instruments which have, or even which have not, keys, is that which we call *temperament*.

103 Its definition.

69. It results then from all that we have now said, that the theory of temperament may be reduced to this question.—The alternate succession of fifths and fourths having been given, UT, SOL, *re*, LA, *mi*, *fi*, *fa*%, *ut*%, *sol*%, *re*%, *la*%, *mi*%, *fi*%, in which *fi* or *ut* is not the true octave of the first UT, it is proposed to alter all the fifths equally, in such a manner that the two *ut*'s may be in a perfect octave the one to the other.

104 Principle whence its theory may be deduced.

70. For a solution of this question, we must begin with tuning the two *ut*'s in a perfect octave the one to the other; in consequence of which, we will render all the semitones which compose the octave as equal as possible. By this means ( $\tau$ ) the alteration made in each fifth will be very inconsiderable, but equal in all

105 Practical directions for temperament.

the rest till you arrive at *fi*%, which will be found  $\frac{3314441}{702223}$ . This fraction is evidently greater than the number 2, which expresses the perfect octave *ut* to its correspondent UT; and the octave below *fi* would be one half of the same fraction, that is to say  $\frac{16572205}{702223}$ , which is evidently greater than UT represented by unity. This last fraction  $\frac{16572205}{702223}$  is composed of two numbers; the numerator of the fraction is nothing else but the number 3 multiplied 11 times in succession by itself, and the denominator is the number 2 multiplied 18 times in succession by itself. Now it is evident, that this fraction, which expresses the value of *fi*%, is not equal to the unity which expresses the value of the found UT; though, upon the harpsichord, *fi*%, and UT are identical. This fraction rises above unity by  $\frac{22441}{702223}$ , that is to say, by about  $\frac{1}{31}$ ; and this difference was called the *comma of Pythagoras*. It is palpable that this comma is much more considerable than that which we have already mentioned, note (*n*), and which is only  $\frac{1}{53}$ .

We have already proved that the series of fifths produces an *ut* different from *fi*%, the series of thirds major gives another still more different. For, let us suppose this series of thirds, *ut*, *mi*, *sol*%, *fi*%, we shall have *mi* equal to  $\frac{1}{3}$ , *sol*% to  $\frac{2}{3}$ , and *fi*% to  $\frac{10}{27}$ , whose octave below is  $\frac{10}{54}$ ; from whence it appears that this last *fi* is less than unity (that is to say, than *ut*), by  $\frac{1}{54}$ , or by  $\frac{1}{27}$ , or near it: A new comma, much greater than the preceding, and which the Greeks have called *apotope major*.

It may be observed, that this *fi*%, deduced from the series of thirds, is to the *fi*% deduced from the series of fifths, as  $\frac{16572205}{702223}$  is to  $\frac{3314441}{702223}$ ; that is to say, in multiplying by 524288, as 125 multiplied by 4096 is to 531441, or as 1200 to 531441, that is to say, nearly as 26 is to 27: from whence it may be seen, that the two *fi*'s are very considerably different one from the other, and even sufficiently different to make the ear sensible of it; because the difference consists almost of a minor semitone, whose value, as will afterwards be seen (art. 139), is  $\frac{1}{12}$ .

Moreover, if, after having found the *sol*% equal to  $\frac{2}{3}$ , we then tune by fifths and by fourths, *sol*%, *re*%, *la*%, *mi*%, *fi*%, as we have done with respect to the first series of fifths, we find that the *fi*% must be  $\frac{2011}{37}$ ; its difference, then, from unity, or, in other words, from UT, is  $\frac{1}{37}$ ; that is to say, about  $\frac{1}{37}$ ; a comma still less than any of the preceding, and which the Greeks have called *apotope minor*.

In a word, if, after having found *mi* equal to  $\frac{1}{3}$  in the progression of thirds, we then tune by fifths and fourths *mi*, *fi*, *fa*%, *ut*%, &c. we shall arrive at a new *fi*%, which shall be  $\frac{11805}{37}$ , and which will not differ from unity but by about  $\frac{1}{37}$ , which is the least and smallest of all the commas; but it must be observed, that, in this case, the thirds major from *mi* to *sol*%, from *sol*% to *fi*% or *ut*, &c. are extremely false, and greatly altered.

( $\tau$ ) All the semitones being equal in the temperament proposed by M. Rameau, it follows, that the twelve semitones *ut*, *ut*%, *re*, *re*%, *mi*, *mi*%, &c. shall form a continued geometrical progression; that is to say, a series in which *ut* shall be to *ut*% in the same proportion as *ut*% to *re*, as *re* to *re*%, &c. and so of the rest.

These

Theory of of them.  
Harmony.

106  
Rameau's  
method of  
tempera-  
ment pro-  
posed.

71. In this, then, the theory of temperament consists: but as it would be difficult in practice to tune a harpsichord or organ by thus rendering all the semitones equal, M. Rameau, in his *Generation Harmonique*, has furnished us with the following method, to alter all the fifths as equally as possible.

72. Take any key of the harpsichord which you please, but let it be towards the middle of the instrument; for instance, UT: then tune the note SOL a fifth above it, at first with as much accuracy as possible; this you may imperceptibly diminish: tune afterwards the fifth to this with equal accuracy, and diminish it in the same manner; and thus proceed from one fifth to another in ascent: and as the ear does not appreciate so exactly sounds that are extremely sharp, it is necessary, when by fifths you have risen to notes extremely high, that you should tune in the most perfect manner the octave below the last fifth which you had imme-

diately formed; then you may continue always in the same manner; till in this process you arrive at the last fifth from *mi* to *fa*%, which should of themselves be in tune; that is to say, they ought to be in such a state, that *fa*%, the highest note of the two which compose the fifth, may be identical with the found UT, with which you began, or at least the octave of that found perfectly just: it will be necessary then to try if this UT, or its octave, forms a just fifth with the last found *mi* or *fa* which has been already tuned. If this be the case, we may be certain that the harpsichord is properly tuned. But if this last fifth be not true, in this case it will be too sharp, and it is an indication that the other fifths have been too much diminished, or at least some of them; or it will be too flat, and consequently discover that they have not been sufficiently diminished. We must then begin and proceed as formerly, till we find the last fifth in tune of itself, and without our immediate interposition (v).

By

These twelve semitones are formed by a series of thirteen sounds, of which UT and its octave *ut* are the first and last. Thus to find by computation the value of each found in the temperament, which is the present object of our speculations, our scrutiny is limited to the investigation of eleven other numbers between 1 and 2 which may form with the 1 and the 2 a continued geometrical progression.

However little any one is practised in calculation, he will easily find each of these numbers, or at least a number approaching to its value. These are the characters by which they may be expressed, which mathematicians will easily understand, and which others may neglect.

UT	<i>ut</i> %	<i>re</i>	<i>re</i> %	<i>mi</i>	<i>fa</i>	<i>fa</i> %	<i>sol</i>	<i>sol</i> %
1	$\sqrt[12]{2}$	$\sqrt[12]{2^2}$	$\sqrt[12]{2^3}$	$\sqrt[12]{2^4}$	$\sqrt[12]{2^5}$	$\sqrt[12]{2^6}$	$\sqrt[12]{2^7}$	$\sqrt[12]{2^8}$
<i>la</i>	<i>la</i> %	<i>fi</i>	<i>ut</i>					
$\sqrt[12]{2^9}$	$\sqrt[12]{2^{10}}$	$\sqrt[12]{2^{11}}$	$\sqrt[12]{2}$					

It is obvious, that in this temperament all the fifths are equally altered. One may likewise prove, that the alteration of each in particular is very inconsiderable; for it will be found, for instance, that the fifth from *ut* to *sol*, which should be  $\frac{3}{2}$ , ought to be diminished by about  $\frac{1}{17}$  of  $\frac{3}{2}$ ; that is to say, by  $\frac{1}{17 \times \frac{3}{2}}$ , a quantity almost inconceivably small.

It is true, that the thirds major will be a little more altered; for the third major from *ut* to *mi*, for instance, shall be increased in its interval by about  $\frac{1}{100}$ : but it is better, according to M. Rameau, that the alteration should fall upon the third than upon the fifth, which after the octave is the most perfect chord, and from the perfection of which we ought never to degenerate but as little as possible.

Besides, it has appeared from the series of thirds major *ut*, *mi*, *sol*%, *fi*%, that this last *fi*% is very different from *ut* (note s); from whence it follows, that if we would tune this *fi*% in unison with the octave of *ut*, and alter at the same time each of the thirds major by a degree as small as possible, they must all be equally altered. This is what occurred in the temperament which we propose; and if in it the third be more altered than the fifth, it is a consequence of the difference which we find between the degrees of perfection in these intervals; a difference, with which, if we may speak so, the temperament proposed conforms itself. Thus this diversity of alteration is rather advantageous than inconvenient.

(v) All that remains, is to acknowledge, with M. Rameau, that this temperament is far remote from that which is now in practice: you may here see in what this last temperament consists as applied to the organ or harpsichord. They begin with UT in the middle of the keys, and they flatten the four first fifths *sol*, *re*, *la*, *mi*, till they form a true third major from *mi* to *ut*; afterwards, setting out from this *mi*, they tune the fifths *fi*, *fa*%, *ut*%, *sol*%, but flattening them still less than the former, so that *sol*% may almost form a true third major with *mi*. When they have arrived at *sol*%, they stop; they resume the first *ut*, and tune to it the fifth *fa* in descending, then the fifth *fi*, &c. and they heighten a little all the fifths till they have arrived at *la*%, which ought to be the same with the *sol*% already tuned.

If, in the temperament commonly practised, some thirds are found to be less altered than in that prescribed by M. Rameau, in return, the fifths in the first temperament are much more false, and many thirds are likewise so; inasmuch, that upon a harpsichord tuned according to the temperament in common use, there are five or six modes which the ear cannot endure, and in which it is impossible to execute any thing. On the contrary, in the temperament suggested by M. Rameau, all the modes are equally perfect; which is a new argument in its favour, since the temperament is peculiarly necessary in passing from one mode to another, without shocking the ear; for instance, from the mode of *ut* to that of *sol*, from the mode of *sol* to that of *re*, &c. It is true, that this uniformity of modulation will to the greatest number of musicians appear a defect: for they imagine, that, by tuning the semitones of the scale unequal, they give each of the modes a peculiar character;

fo

Theory of  
Harmony.

By this method all the twelve sounds which compose one of the scales shall be tuned: nothing is necessary but to tune with the greatest possible exactness their octaves in the other scales, and the harpsichord shall be well tuned.

107  
Alterations  
by either  
method  
hardly dis-  
agreeable.

We have given this rule for temperament, from M. Rameau; and it belongs only to disinterested artists to judge of it. However this question be determined, and whatever kind of temperament may be received, the alterations which it produces in harmony will be but very small, or not perceptible to the ear, whose attention is entirely engrossed in attuning itself with the fundamental bass, and which suffers, without uneasiness, these alterations, or rather takes no notice of them, because it supplies from itself what may be wanting to the truth and perfection of the intervals.

Simple and daily experiments confirm what we now advance. Listen to a voice which is accompanied, in singing, by different instruments; though the tempe-

rament of the voice, and the temperaments of each of the instruments, are all different one from another, yet you will not be in the least affected with the kind of cacophony which ought to result from these diversities, because the ear supposes these intervals true of which it does not appreciate the differences.

We may give another experiment. Strike upon an organ the three keys *mi, sol, si*, you will hear nothing but the minor perfect chord; tho' *mi*, by the construction of that instrument, must cause *sol* likewise to be heard; though *sol* should have the same effect upon *re*, and *si* upon *fa*%; inasmuch, that the ear is at once affected with all these sounds, *re, mi, fa, sol, si*: how many dissonances perceived at the same time, and what a jarring multitude of discordant sensations, would result from thence to the ear, if the perfect chord with which it is preoccupied had not power entirely to abstract its attention from such sounds as might offend!

Theory of  
Harmony.

CHAP.

fo that, according to them, the scale of *ut*,

*ut, re, mi, fa, sol, la, si, UT,*  
is not perfectly similar to the gammut or diatonic scale of the mode of *mi*,  
*mi, fa, sol, la, si, ut, re, mi,*

which, in their judgment, renders the modes of *ut* and *mi* proper for different manners of expression. But after all that we have said in this treatise on the formation of diatonic intervals, every one should be convinced, that, according to the intention of nature, the diatonic scale ought to be perfectly the same in all its modes: The contrary opinion, says M. Rameau, is a mere prejudice of musicians. The character of an air arises chiefly from the intermixture of the modes; from the greater or lesser degrees of vivacity in the movement; from the tones, more or less grave, or more or less acute, which are assigned to the generator of the mode; and from the chords more or less beautiful, as they are more or less deep, more or less flat, more or less sharp, which are found in it.

In short, the last advantage of this temperament is, that it will be found conformable, or at least very little different from that which they practise upon instruments without keys; as the bass-viol, the violin, in which true fifths and fourths are preferred to thirds and sixths tuned with equal accuracy; a temperament which appears incompatible with that commonly used in tuning the harpsichord.

Yet we must not suffer our readers to be ignorant, that M. Rameau, in his *New System of Music*, printed in 1726, had adopted the ordinary temperament. In that work, (as may be seen CHAP. XXIV.), he pretends that the alteration of the fifths is much more supportable than that of the thirds major; and that this last interval can hardly suffer a greater alteration than the octave, which, as we know, cannot suffer the slightest alteration. He says, that if three strings are tuned, one by an octave, the other by a fifth, and the next by a third major to a fourth string, and if a sound be produced from the last, the string tuned by a fifth will vibrate, though a little less true than it ought to have been; but that the octave and the third major, if altered in the least degree, will not vibrate: and he adds, that the temperament which is now practised, is founded upon that principle. M. Rameau goes still farther; and as, in the ordinary temperament, there is a necessity for altering the last thirds major, and to make them a little more sharp, that they may naturally return to the octave of the principal sound, he pretends that this alteration is tolerable, not only because it is almost insensible, but because it is found in modulations not much in use, unless the composer should choose it on purpose to render the expression stronger. "For it is proper to remark, (says he), that we receive different impressions from the intervals in proportion to their different alterations: for instance, the third major, which naturally elevates us to joy, in proportion as we feel it, heightens our feelings even to a kind of fury, when it is tuned too sharp; and the third minor, which naturally inspires us with tenderness and serenity, depresses us to melancholy when it is too flat." All this strain, as you may see, is immensely different from that which this celebrated musician afterwards exhibited in his *Generation Harmonique*, and in the performances which followed it. From this we can only conclude, that the reasons, which, after him, we have urged for the new temperament, must without doubt have appeared to him very strong, because in his mind they have superseded those which he had formerly adduced in favour of the ordinary temperament.

We do not pretend to give any decision for either the one or the other of these methods of temperament, each of which appears to us to have its particular advantages. We shall only remark, that the choice of the one or the other must be left absolutely to the taste and inclination of the reader; without, however, admitting this choice to have any influence upon the principles of the system of music, which we have followed even till this period, and which must always subsist, whatever temperament we adopt.

CHAP. VIII. *Of Repose or Cadences* (†).

73. IN a fundamental bass whose procedure is by fifths, there always is, or always may be, a *repose*, or *crisis*, in which the mind acquiesces in its transition from one found to another: but a *repose* may be more or less distinctly signified, and of consequence more or less perfect. If one should rise by fifths; if, for instance, we pass from *ut* to *sol* it is the generator which passes to one of these fifths, and this fifth was already pre-existent in its generator: but the generator exists no longer in this fifth; and the ear, as this generator is the principle of all harmony and of all melody, feels a desire to return to it. Thus the transition from a found to its fifth in ascent, is termed an *imperfect repose*, or *imperfect cadence*; but the transition from any found to its fifth in descent, is denominated a *perfect cadence*, or an *absolute repose*: it is the offspring which returns to its generator, and as it were recovers its existence once more in that generator itself, with which when founding it resounds (chap. i.)

74. Amongst absolute *reposes*, there are some, if we may be allowed the expression, more absolute, than is to say, more perfect, than others. Thus in the fundamental bass

*ut, sol, ut, fa, ut, sol, re, sol, ut,*

which forms, as we have seen, the diatonic scale of the moderns, there is an absolute repose from *re* to *sol*, as from *sol* to *ut*: yet this last absolute repose is more perfect than the preceding, because the ear, prepossessed with the mode of *ut* by the multiplied impression of the found *ut* which it has already heard thrice before, feels a desire to return to the generator *ut*; and it accordingly does so, by the absolute repose *sol, ut*.

75. We may still add, that what is commonly called *cadence* in melody, ought not to be confounded with what we name *cadence* in harmony.

In the first case, this word only signifies an agreeable and rapid alternation between two contiguous sounds, called likewise a *trill* or *shake*; in the second, it signifies a repose or close. It is however true, that this *shake* implies, or at least frequently enough prefigures, a repose, either present or impending, in the fundamental bass (x).

76. Since there is a repose in passing from one found to another in the fundamental bass, there is also a repose in passing from one note to another in the diatonic scale, which is formed from it, and which this bass represents: and as the absolute repose *sol, ut*, is of all others the most perfect in the fundamental bass, the repose from *si* to *ut*, which answers to it in the scale, and which is likewise terminated by the generator, is for that reason the most perfect of all others in the diatonic scale ascending.

77. It is then a law dictated by nature itself, that

if you would ascend diatonically to the generator of a mode, you can only do this by means of the third major from the fifth of that very generator. This third major, which with the generator forms a semitone, has for that reason been called the *sensible note*, as in See *Sensible Note*. producing the generator, and preparing us for the most perfect repose.

We have already proved, that the fundamental bass is the principle of melody. We shall besides make it appear in the sequel, that the effect of a repose in melody arises solely from the fundamental bass.

CHAP. IX. *Of the Minor Mode and its Diatonic Series.*

78. IN the second chapter, we have explained (art. 29. 30. 31. and 32.) by what means, and upon what principle the minor chord *ut, mi, sol*, may be formed, which is the characteristic chord of the minor mode. Now what we have there said, taking *ut* for the principal and fundamental found, we might likewise have said of any other note in the scale, assumed in the same manner as the principal and fundamental found: but as in the minor chord *ut, mi, sol, ut*, there occurs a *mi* which is not found in the ordinary diatonic scale, we shall immediately substitute, for greater ease and convenience, another chord, which is likewise minor and exactly similar to the former, of which all the notes are found in the scale.

79. The scale affords us three chords of this kind, viz. *re, fa, la, re, la, ut, mi, la*, and *mi, sol, si, mi*. Amongst these three we shall choose *la, ut, mi, la*; because this three we shall not including any sharp or flat, has two founds in common with the major chord *ut, mi, sol, ut*; and besides, one of these two founds is the very same *ut*: so that this chord appears to have the most immediate, and at the same time the most simple, relation with the chord *ut, mi, sol, ut*. Concerning this we need only add, that this preference of the chord *la, ut, mi, la*, to every other minor chord, is by no means in itself necessary for what we have to say in this chapter upon the diatonic scale of the minor mode. We might in the same manner have chosen any other minor chord; and it is only, as we have said, for greater ease and convenience, that we fix upon this.

80. Let us now remark, that in every mode, whether major or minor, the *principal* found which implies the perfect chord, whether major or minor, may be called the *tonic note* or *key*; thus *ut* is the key in its proper mode, *la* in the mode of *la*, &c. Having laid down this principle,

81. We have shown how the three founds *fa, ut, sol*, which constitutes (art. 38.) the mode of *ut*, of which the first *fa* and the last *sol* are the two fifths of the one descending the other rising, produce the scale.

(†) That the reader may have a clear idea of the term before he enters upon the subject of this chapter, it may be necessary to caution him against a mistake into which he may be too easily led, by the ordinary signification of the word *repose*. In music, therefore, it is far from being synonymous with the word *rest*. It is, on the contrary, the termination of a musical phrase which ends in a cadence more or less emphatic, as the sentiment implied in the phrase is more or less complete. Thus a repose in music answers the same purpose as punctuation in language. See *REPOS* in Rousseau's Musical Dictionary.

(x) M. Rousseau, in his letter on French music, has called this alternate undulation of different founds a *trill*, from the Italian word *trillo*, which signifies the same thing; and some French musicians already appear to have adopted this expression.

Theory of Harmony.

The diatonic series of the minor mode ascertained by different examples.

The tonic key in harmony, what. See Principle. See Tonic.

The formation of the diatonic scale pursued.

Theory of *fi, ut, re, mi, fa, sol, la,* of the major mode, by means of the fundamental bas*is sol, ut, fa, ut,*

Theory of *sol* Harmony.

See fig. D. *fa* : let us in the same manner take the three founds *re, la, mi,* which constitute the mode of *la,* for the same reason that the founds *fa, ut, sol,* constitute the mode of *ut* ; and of them let us form this fundamental

See fig G. bas*is,* perfectly like the preceding, *mi, la, mi, la, re, la, re* : let us afterwards place below each of these founds one of their harmonics, as we have done (chap. v.) for the first scale of the major mode ; with this difference, that we must suppose *re* and *la* as implying their thirds minor in the fundamental bas*is* characterise the minor mode ; and we shall have the diatonic scale of that mode,

*sol*%, *la, fi, ut, re, mi, fa.*

82. The *sol*%, which corresponds with *mi* in the fundamental bas*is,* forms a third major with that *mi,* though the mode be minor ; for the same reason that a third from the fifth of the fundamental found ought to be major (art. 77.) when that third rises to the fundamental found *la.*

See ImPLY or Carry.

83. It is true, that, in causing *mi* to imply its third major *sol,* one might also rise to *la* by a diatonic progress. But that manner of rising to *la* would be less perfect than the preceding ; for this reason (art. 76.) that the absolute repose or perfect cadence *mi, la,* which is found in the fundamental bas*is,* ought to be represented in the most perfect manner in the two notes of the diatonic scale which answer to it, especially when one of these two notes is *la,* the key itself upon which the repose is made. From whence it follows, that the preceding note *sol* ought rather to be sharp than natural ; because *sol*%, being included in *mi* (art. 19.), much more perfectly represents the note *mi* in the bas*is,* than the natural note *sol* could do, which is not included in *mi.*

116 Diverfities in the fates of the major and minor mode.

84. We may remark this first difference between the scale *sol*%, *la, , ut, re, mi, fa,* and the scale which corresponds with it in the major mode

*fi, ut, re, mi, fa, sol, la,*

that from *mi* to *fa,* which are the two last notes of the former scale, there is only a semitone ; whereas from *sol* to *la,* which are the two last founds of the latter series, there is the interval of a complete tone : but this is not the only discrimination which may be found between the scales of the two modes.

117 Investiga-tion of the differences and their reasons.

85. To investigate these differences, and to discover the reason for which they happen, we shall begin by forming a new diatonic scale of the minor mode, similar to the second scale of the major mode,

*ut, re, mi, fa, sol, sol, la, fi, ut.*

That last series, as we have seen, was formed by means of the fundamental bas*is fa, ut, sol, re,* disposed in this manner,

*ut, sol, ut, fa, ut, sol, re, sol, ut.*

Let us take in the same manner the fundamental bas*is re la mi fi,* and arrange it in the following order,

*la, mi, la, re, la, mi, fi, mi, la,*

and it will produce the scale immediately subjoined, *la, fi, ut, re, mi, mi, fa*%, *sol*%, *la,* in which *ut* forms a third minor with *la,* which in the fundamental bas*is* corresponds with it, which denomi-

See fig. H.

nates the minor mode : and on the contrary *sol*%, Theory of forms a third major with *mi* in the fundamental bas*is,* Harmony. because *sol*% rises towards *la,* (art. 82. and 83.)

86. We see besides a *fa*%, which does not occur in the former,

*sol*%, *la, fi, ut, re, mi, fa,*

where *fa* is natural. It is because, in the first scale, *fa* is a third minor from *re* in the bas*is* ; and in the second, *fa*% is the fifth from *fi* in the bas*is.*

87. Thus the two scales of the minor mode are still in this respect more different one from the other than the two scales of the major mode ; for we do not remark this difference of a semitone between the two scales of the major mode. We have only observed (art. 63.) some difference in the value of *la* as it stands in each of these scales, but this amounts to much less than a semitone.

88. From thence it may be seen why *fa* and *sol* are sharp when ascending in the minor mode ; nay, be sharp in the sides, the *fa* is only natural in the first scale *sol*%, *la, fi, ut, re, mi, fa,* because this *fa* cannot rise to *sol*%, (art. 48.)

89. It is not the same case in descending. For *mi,* the fifth of the generator, ought not to imply the third major *sol*%, but in the case when that *mi* descends to the generator *la* to form a perfect repose, (art. 77. and 83.) ; and in this case the third major *sol*% rises to the generator *la* : but the fundamental bas*is la* may, in descending, give the scale *la sol* natural, provided *sol* does not rise towards *la.*

90. It is much more difficult to explain how the *fa,* which ought to follow this *sol* in descending, is natural and not sharp ; for the fundamental bas*is* produces in descending, *la, mi, fi, mi, la, re, la, mi, la,*

*la, sol, fa*%, *mi, mi, re, ut, fi, la.*

And it is plain that the *fa* cannot be otherwise than sharp, since *fa*% is the fifth of the note *fi* of the fundamental bas*is.* In the mean time, experience evinces that the *fa* is natural in descending in the diatonic scale of the major mode of *la,* especially when the preceding *sol* is natural ; and it must be acknowledged, that here the fundamental bas*is* appears in some measure defective.

M. Rameau has invented the following means for obtaining a solution of this difficulty. According to him, in the diatonic scale of the minor mode in descending, *la, sol, fa, mi, re, ut, fi, la, sol,* may be regarded simply as a note of passage, merely added to give sweetness to the modulation, and as a diatonic gradation by which we may descend to *fa* natural. It is easily perceived, according to M. Rameau, by this fundamental bas*is,*

*la, re, la, re, la, mi, la,*

which produces *la, fa, mi, re, ut, fi, la* ; which may be regarded, as he says, as the real scale of the minor mode in descending ; to which is added *sol* natural between *la* and *fa,* to preserve the diatonic order.

This answer appears the only one which can be given to the difficulty above proposed : but I know not whether it will fully satisfy the reader ; whether he will not see with regret, that the fundamental bas*is* does not produce, to speak properly, the diatonic scale of the minor

118 Difference between the two scales of the minor mode greater than those of the major.

119 The case different in descending, and why.

120 The case different in descending, and why.

121 Explication of the descending scale in the minor mode from a fundamental bas*is* difficult.

122 Rameau's solution, though the only one, get unjustifi-catory.



Theory of  
Harmony.

minor mode in descent, when at the same time this same bass for happily produces the diatonic scale of that identical mode in ascending, and the diatonic scale of the major mode whether in rising or descending (y).

### CHAP. X. Of relative Modes.

91. Two modes which are of such a nature that we can pass from the one to the other, are called *relative modes*. Thus we have already seen, that the major mode of *ut* is relative to the major mode of *fa* and to that of *sol*. It may likewise appear from what goes before, how many intimate connections there are between the *species* (+) or major mode of *ut*, and the *species* or minor mode of *la*. For, 1. The perfect chords, one major *ut mi sol ut*, the other minor *la ut mi la*, which characterise each of those two kinds of modulation \* or harmony, have two sounds in common, *ut* or *mi*. 2. The diatonic scale of the minor mode of *la* in descent, absolutely contains the same sounds with the gammut or diatonic scale of the major mode of *ut*.

It is for this reason that the transition is so natural and easy from the major mode of *ut* to the minor mode of *la*, or from the minor mode of *la* to the major mode of *ut*, as experience proves.

92. In the minor mode of *mi*, the minor perfect chord *mi sol fa mi*, which characterises it, has likewise two sounds, *mi, sol*, in common with the perfect chord major *ut mi sol ut*, which characterises the major mode of *ut*. But the minor mode of *mi* is not so closely related nor allied to the major mode of *ut* as to the minor mode of *la*; because the diatonic scale of the minor mode of *mi* in descent has not, like the series of the minor mode of *la*, all these sounds in common with the scale of *ut*. In reality, this scale is *mi re ut fa la sol fa*  $\&$  *mi*, where there occurs a *fa* sharp which is not in the scale of *ut*. We may add; that though the minor mode of *mi* is less relative to the major mode of *ut* than that of *la*; yet the artist does not hesitate some-

2

(y) For what remains when *sol* is said to be natural in descending the diatonic scale of the minor mode of *la*, this only signifies, that this *sol* is not necessarily sharp in descending as it is in rising; for this *sol*, besides, may be sharp in descending to the minor mode of *la*, as may be proved by numberless examples, of which all musical composers are full. It is true, that when the found *sol* is found sharp in descending to the minor mode of *la*, still we are not sure that the mode is minor till the *fa* or *ut* natural is found; both of which impress a peculiar character on the minor mode, viz. *ut* natural, in rising and in descending, and the *fa* natural in descending.

(t) *Species* was the only word which occurred to the translator in English by which he could render the French word *genre*. It is, according to Rousseau, intended to express the different divisions and dispositions of the intervals which formed the two tetrachords in the ancient diatonic scale; and as the gammut of the moderns consists likewise of two tetrachords, though diversified from the former, as our author has shown at large, the *genre*, or *species* as the translator has been obliged to express it, must consist in the various dispositions and divisions of the different intervals between the notes or semitones which compose the modern scale.

(z) There are likewise other minor modes, into which we may pass in our egress from the mode major of *ut*; as that of *fa* minor, in which the perfect minor chord *fa, la, ut*, includes the found *ut*, and whose scale in ascent *fa, sol, la, b, si, ut, re, mi, fa*, only includes the two sounds *la, b, si*, which do not occur in the scale of *ut*. We find an example of this transition from the mode major of *ut* to that of *fa* minor, in the opera of *Pygmalion* by M. Rameau, where the *sarabando* is in the minor mode of *fa*, and the *rigadon* in the mode major of *ut*. This kind of transition, however, is not frequent.

The minor mode of *re* has only in its scale ascending *re, mi, fa, sol, la, si, ut*  $\&$ , *re*, one *ut* sharp which is not found in the scale of *ut*. For this reason a transition may likewise be made, without grating the ear, from the mode of *ut* major to the mode of *re* minor; but this passage is less immediate than the former, because the chords *ut, mi, sol, ut, re, fa, la, re*, not having a single found in common, one cannot (art. 37.) pass immediately from the one to the other.

times to pass immediately from the one to the other.

Of this may be seen one instance (among many others) in the prologue *des Amours des Dieux*, at this passage, *Osido est l'objet de la fete*, which is in the minor mode of *mi*, though what immediately precedes it is in the major mode of *ut*.

We may see besides, that when we pass from one mode to another by the interval of a third, whether in descending or rising, as from *ut* to *la*, or from *la* to *ut*, from *ut* to *mi*, or from *mi* to *ut*, the major mode becomes minor, or the minor mode becomes major.

93. There is still another minor mode, into which an immediate transition may be made in issuing from the major mode of *ut*. It is the minor mode of *ut* itself in which the perfect minor chord *ut mi sol ut* has two sounds, *ut* and *sol*, in common with the perfect major chord *ut mi sol ut*. Nor is there any thing more common than a transition from the major mode of *ut* to the minor mode, or from the minor to the major (z).

### CHAP. XI. Of Dissonance.

94. We have already observed, that the mode of *ut* (*fa, ut, sol*) has two sounds in common with the mode of *sol*, (*ut, sol, re*); and two sounds in common with the mode of *fa* (*si, fa, ut*); of consequence this procedure of the bass *ut sol*, may belong to the mode of *ut*, or to the mode of *sol*, as the procedure of the bass *fa ut*, or *ut fa*, may belong to the mode of *ut* or the mode of *fa*. When any one therefore passes from *ut* to *sol* or from *sol* to *fa* in a fundamental bass, he is still ignorant even to that crisis what mode he is in. It would be however advantageous to know it, and to be able by some means to distinguish the generator from his fifths.

95. This advantage may be obtained by uniting at the same time the sounds *sol* and *fa* in the same harmony, that is to say, by joining to the harmony *sol si re* of the fifth *sol*, the other fifth *fa* in this manner, [ e ]

Theory of  
Harmony.124  
Cases in  
which the  
mode is un-  
certain.125  
How we  
may investigate  
the generator  
and its  
fifths, and  
by that  
means determine  
the mode.123  
Modes re-  
lative,  
what.  
See  
Mode.\* See Mo-  
dulation.

Theory of Harmony

sol, si, re, fa; this fa which is added, forms a dissonance with sol (art. 18.) It is for that reason that the chord sol, si, re, fa, is called a dissonant chord, or a chord of the seventh. It serves to distinguish the fifth sol from the generator ut, which always implies, without mixture or alteration, the perfect chord ut, mi, sol, ut, resulting from nature itself (art. 32.) By this we may see, that when we pass from ut to sol, one passes at the same time from ut to fa, because fa is found to be comprehended in the chord of sol; and the mode of ut by these means plainly appears to be determined, because there is none but that mode to which the founds fa and sol act once below.

116 Manner of treating dissonances continued.

96. Let us now see what may be added to the harmony fa, la, ut, of the fifth fa below the generator, to distinguish this harmony from that of the generator. It seems probable at first, that we should add to it the other fifth sol, so that the generator ut, in passing to fa, may at the same time pass to sol, and that by this the mode should be determined: but this introduction of sol, in the chord fa, la, ut, would produce two seconds in succession fa, sol, sol, la, that is a two way, two dissonances whose union would prove extremely harsh to the ear; an inconvenience which ought carefully to be avoided. For if, to distinguish the mode, we should alter the harmony of the fifth fa in the fundamental bass, it must only be altered in the least degree possible.

117 Chord of the great sixth.

97. For this reason, instead of sol, we shall take its fifth re, which is the found that approaches it the nearest; and we shall have, instead of the fifth fa, the chord fa, la, ut, re, which is called a chord of the great sixth.

One may here remark the analogy there is observed between the harmony of the fifth sol, and that of the fifth fa.

118 The subject of dissonances continued.

98. The fifth sol, in rising above the generator, gives a chord entirely consisting of thirds ascending from sol, sol, si, re, fa; now the fifth fa being below the generator ut in descending, we shall find, as we go lower by thirds from ut towards fa, the same founds ut, la, fa, re, which form the chord fa, la, ut, re, given to the fifth fa.

99. It appears besides, that the alteration of the harmony in the two fifths consists only in the third minor re, fa, which was reciprocally added to the harmony of these two fifths.

CHAP. XII. Of the Double Use, or Employment of Dissonance.

Theory of Harmony.

100. It is evident by the resemblance of founds to their octaves, that the chord fa, la, ut, re, is in effect the same as the chord re, fa, la, ut, taken inversely \* that the inverse of the chord ut, la, fa, re, has been found (art. 98.) in descending by thirds from the generator ut (AA).

119 Account of the double employment. \* See Inverted.

101. The chord re, fa, la, ut, is a chord of the seventh like the chord sol, si, re, fa: with this only difference, that in this the third sol, si, is major; whereas in the second, the third re, fa, is minor. If the fa were sharp, the chord re, fa, la, ut, would be a genuine chord of the dominant, like the chord sol, si, re, fa; and as the dominant sol may descend to ut in the fundamental bass, the dominant re implying or carrying with the third major fa might in the same manner descend to sol.

120 Difference between dominant and tonic dominant.

102. Now I say, that if the fa ♯ should be changed into fa natural, re, the fundamental tone of this chord re, fa, la, ut, might still descend to sol; for the change from fa ♯ to fa natural, will have no other effect, than to preserve the impression of the mode of ut, instead of that of the mode of sol, which the fa ♯ would have here introduced. For what remains, the note re will always preserve its character as the dominant, on account of the mode of ut, which forms a seventh. Thus in the chord of which we treat, re, fa, la, ut, re, may be considered as an imperfect dominant; I call it imperfect, because it carries with it the third minor fa, instead of the third major fa ♯. It is for this reason that in the sequel I shall call it simply the dominant, to distinguish it from the dominant sol, which shall be named the tonic dominant.

See Dominant.

103. Thus the founds fa and sol, which cannot succeed each other (art. 36.) in a diatonic bass, when they only carry with them the perfect chords fa, la, ut, sol, si, re, may succeed one another if you join re to the harmony of the first, and fa to the harmony of the second; and if you invert the first chord, that is to say, if you give to the two chords this form, re, fa, la, ut, sol, si, re, fa.

104. Besides, the chord fa, la, ut, re, being allowed to succeed the perfect chord ut, mi, sol, ut, it follows cited.

121 Seeming contradictions follows cited.

(AA) "M. Rameau, in several passages of his works, (for instance, in p. 110, 111, 112, and 113, of the Generation Harmonique,) appears to consider the chord re, fa, la, ut, as the primary chord and generator of the chord fa, la, ut, re, which is nothing but that chord itself reversed; in other passages (particularly in p. 116 of the same performance), he seems to consider the first of these chords as nothing else but the reverse of the second. It would seem that this great artist has neither expressed himself upon this subject with so much uniformity nor with so much precision as is required. For my own part, I think there is some foundation for considering the chord fa, la, ut, re, as primitive; 1. Because in this chord, the fundamental and principal note is the sub-dominant fa, which ought in effect to be the fundamental and principal found in the chord of the sub-dominant. 2. Because that without having recourse, with M. Rameau, to harmonical and arithmetical progressions, of which the consideration appears to us quite foreign to the question, we have found a probable and even a satisfactory reason for adding the note re to the harmony of the fifth fa, (art. 96 and 97.) The origin thus assigned for the chord of the sub-dominant appears to us the most natural, though M. Rameau does not appear to have felt its full value; for scarcely has it been slightly insinuated by him."

Thus far our author. We do not enter with him into the controversy concerning the origin of the chord in question; but only propose to add to his definition of the sub-dominant, Rousseau's idea of the same note. It is a name, says he, given by M. Rameau to the fourth note in any modulation relative to a given key, which of consequence is in the same interval from the key in descending as the dominant in rising; from which circumstance it takes its name.

Theory of follows for the same reasons, that the chord *ut, mi, sol, ut*, may be succeeded by *re, fa, la, ut*; which is not contradictory to what we have above said (art. 37.), that the sounds *ut* and *re* cannot succeed one another in the fundamental bass: for in the passage quoted, we had supposed that both *ut* and *re* carried with them a perfect chord major; whereas, in the present case, *re* carries the third minor *fa* and likewise the found *ut*, by which the chord *re fa la ut* is connected with that which precedes it *ut mi sol ut*, and in which the found *ut* is found. Besides, this chord, *re fa la ut*, is properly nothing else but the chord *fa la ut re* inverted, and, if we may speak so, disguised.

105. This manner of presenting the chord of the sub-dominant under two different forms, and of employing it under these two different forms, has been called by M. Rameau its *double office* or *employment* \*. This is the source of one of the finest varieties in harmony; and we shall see in the following chapter the advantages which result from it.

We may add, that as this double employment is a kind of licence, it ought not to be practised without some precaution. We have lately seen that the chord *re fa la ut*, considered as the inverse of *fa la ut re*, may succeed to *ut mi sol ut*; but this liberty is not reciprocal: and though the chord *fa la ut re*, may be followed by the chord *ut mi sol ut*, we have no right to conclude from thence that the chord *re fa la ut*, considered as the inverse of *fa la ut re*, may be followed by the chord *ut mi sol ut*. For this the reason shall be given CHAP. XVI.

### CHAP. XIII. Concerning the Use of this Double Employment, and its Rules.

106. We have shown (Chap. vi.) how the diatonic scale, or ordinary gammut, may be formed from the fundamental bass *fa, ut, sol, re*, by twice repeating the word *sol* in that series; so that this gammut is primitively and originally composed of two similar tetrachords, one in the mode of *ut*, the other in that of *sol*. Now it is possible, by means of this double employment, to preserve the impression of the mode of *ut* through the whole extent of the scale, without twice repeating the note *sol*, or even without supposing this repetition. For this effect we have nothing to do but form the following fundamental bass,

*ut, sol, ut, fa, ut, re, sol, ut:*

in which *ut* is understood to carry with it the perfect chord *ut mi sol ut*; *sol*, the chord *sol si re fa*; *fa*, the

chord *fa la ut re*; and *re*, the chord *re fa la ut*. It is plain from what has been said in the preceding chapter, that in this case *ut* may ascend to *re* in the fundamental bass, and *re* descend to *sol*; and that the impression of the mode of *ut* is preserved by the *fa* natural which forms the third minor *re fa*, instead of the third major which *re* ought naturally to imply.

107. This fundamental bass will give, as it is evident, the ordinary diatonic scale,

*ut, re, mi, fa, sol, la, si, UT,*

which of consequence will be in the mode of *ut* alone; and if one should chuse to have the second tetrachord in the mode of *sol*, it will be necessary to substitute *fa* instead of *fa* natural in the harmony of *re* (as).

108. Thus the generator *ut* may be followed according to pleasure in ascending diatonically either by a tonic dominant (*re fa sol la ut*), or by a simple dominant (*re fa la ut*).

109. In the minor mode of *la*, the tonic dominant *mi* ought always to imply its third major *mi sol la*, when this dominant *mi* descends to the generator *la* (art. 83.); and the chord of this dominant shall be *mi sol si re*, entirely similar to *sol si re fa*. With respect to the sub-dominant *re*, it will immediately imply the third minor *fa*, to denominate the minor mode; and we may add *si* above its chord *re fa la*, in this manner *re fa la si*, a chord similar to that of *fa la ut re*; and as we have deduced from the chord *fa la ut re*, that of *re fa la ut*, we may in the same manner deduce from the chord *re fa la si*, a new chord of the seventh *si re fa la*, which will exhibit the *double employment of dissonances* in the minor mode.

110. One may employ this chord *si re fa la*, to preserve the impression of the mode of *la* in the diatonic scale of the minor mode, and to prevent the necessity of twice repeating the found *mi*: but in this case, the *fa* must be rendered sharp, and change this chord to *si re fa sol la*, the fifth of *si* is *fa*, as we have seen above; this chord is then the inverse of *re fa sol la si*, where the sub-dominant implies the third major; which ought not to surprize us. For in the minor mode of *la*, the second tetrachord *mi fa sol la* is exactly the same as it would be in the major mode of *la*; now, in the major mode of *la*, the sub-dominant *re* ought to imply the third major *fa*.

111. From thence we may see that the minor mode is susceptible of a much greater number of varieties in the major: likewise the major mode is the product of nature alone; whereas the minor is, in some measure, than in the major.

[ c 2 ]

(88) We need only add, that it is easy to see, that this fundamental bass *ut sol, ut fa, ut re, sol ut*, which formed the ascending scale, *ut, re, mi, fa, sol, la, si, UT*, cannot by inverting it, and taking it inversely in this manner *si, ut, sol, re, ut, fa, ut, sol, UT*, form the diatonic scale *UT, si, la, sol, mi, re, ut*, in descent. In reality, from the chord *sol, si, re, fa*, we cannot pass to the chord *re, fa, la, ut*, nor from thence to *ut, mi, sol, ut*. It is for this reason that in order to have the fundamental bass of the scale *UT, si, la, sol, fa, mi, re, ut*, in descent, we must either determine to invert the fundamental bass mentioned in art. 55. in this manner, *ut, sol, re, sol, ut, fa, ut, sol, ut*, in which the second *sol* and the second *ut* answer to the *sol* alone in the scale; or otherwise we must form the fundamental bass *ut, sol, re, sol, ut, sol, ut*, in which all the notes imply perfect chords major, except the second *sol*, which implies the chord of the seventh *sol, si, re, fa*, and which answers to the two notes of the scale *sol, fa*, both comprehended in the chord *sol, si, re, fa*.

Which ever of these two basses we shall chuse, it is obvious that neither the one nor the other shall be wholly in the mode of *ut*, but in the mode of *ut* and in that of *sol*. From whence it follows, that the double employment which gives to the scale a fundamental bass all in the same mode when ascending, cannot do the same in descending; and that the fundamental bass of the scale in descending will be necessarily in two different modes.

132  
Double employment, what, and why so called.

\* See Double employment.

133  
By the double use of the above-mentioned chord, the impression of the mode may be preserved.

Theory of Harmony.

134  
Diversities in the minor mode more numerous than in the major.

Theory of  
Harmony

measures, the product of art. But in return, the major mode has received from nature, to which it owes its immediate formation, a force and energy which the minor cannot boast.

CHAP. XIV. *Of the Different Kinds of Chords of the Seventh.*

135  
Investigation whether art, in consequence of some successful advances, may not be carried farther.

112. THE dissonance added to the chord of the dominant and of the sub-dominant, though in some measure insinuated by nature (Chap. xi.), is nevertheless a work of art: but as it produces great beauties in harmony by the variety which it introduces into it, let us discover whether, in consequence of this first advance, art may not still be carried farther.

113. We have already three different kinds of chords of the seventh, viz.

1. The chord *sol si re fa*, composed of a third major followed by two thirds minor.

2. The chord *re fa la ut*, or *si re fa<sup>♯</sup> la*, composed of a third major between two minors.

3. The chord *si re fa la*, composed of two thirds minor followed by a major.

114. There are still two other kinds of chords of the seventh which are employed in harmony; one is composed of a third minor between two thirds major, *ut mi sol si*, or *fa la ut mi*; the other is wholly composed of thirds minor *sol<sup>♯</sup> si re fa*. These two chords, which at first appear as if they ought not to enter into harmony if we rigorously keep to the preceding rules, are nevertheless frequently practised with success in the fundamental bass. The reason is this:

115. According to what has been said above, if we would add a seventh to the chord *ut mi sol*, to make a dominant of *ut*, one can add nothing but *si*; and in this case *ut mi sol si* would be the chord of the tonic dominant in the mode of *fa*, as *sol si re fa* is the chord of the tonic dominant in the mode of *ut*; but if you would preserve the impression of the mode of *ut* in the harmony, you then change this *si* into *si* natural, and the chord *ut mi sol si* becomes *ut mi sol si*. It is the same case with the chord *fa la ut mi*, which is nothing else but the chord *fa la ut mi<sup>b</sup>*; in which one may substitute for *mi<sup>b</sup>*, *mi* natural, to preserve the impression of the mode of *ut*, or of that of *fa*.

Besides, in such chords as *ut mi sol si*, *fa la ut mi*, the sounds *si* and *mi*, though they form a dissonance with *ut* in the first case, and with *fa* in the second, are nevertheless supportable to the ear, because these sounds *si* and *mi* (art. 19.) are already contained and understood, the first in the note *mi* of the chord *ut*

*mi sol si*, as likewise in the note *sol* of the same chord; the second in the note *la* of the chord *fa la ut mi*, as likewise in the note *ut* of the same chord. All together then seem to allow the artist to introduce the note *si* and *mi* into these two chords (cc).

116. With respect to the chord of the seventh *sol<sup>♯</sup> si re fa*, wholly composed of thirds minor, it may be regarded as formed from the union of the two chords of the dominant and of the sub-dominant in the minor mode. In effect, in the minor mode of *la*, for instance, these two chords are *mi sol<sup>♯</sup> si re*, and *re fa la si*, whose union produces *mi, sol<sup>♯</sup>, si, re, fa, la*: Now if we should suffer this chord to remain thus, it would be disagreeable to the ear, by its multiplicity of dissonances, *re mi, mi la, la sol<sup>♯</sup>, la si, re sol<sup>♯</sup>*, (art. 18.); so that, to avoid this inconvenience, the generator *la* is immediately expunged, which (art. 19.) is as it were understood in *re*, and the fifth or dominant *mi* whose place the sensible note *sol<sup>♯</sup>* is supposed to hold: thus there remains no more than the chord *sol<sup>♯</sup> si re fa*, wholly composed of thirds minor, and in which the dominant *mi* is considered as understood; in such a manner that the chord *sol<sup>♯</sup> si re fa*, represents the chord of the tonic dominant *mi sol<sup>♯</sup> si re*, to which we have joined the chord of the sub-dominant *re fa la si*, but in which the dominant *mi* is always reckoned the principal note (dd).

117. Since, then, from the chord *mi sol<sup>♯</sup> si re*, we may pass to the perfect *la ut mi la*, and vice versa; we may in like manner pass from the chord *sol<sup>♯</sup> si re fa*, to the chord *la ut mi la*, and from this last to the chord *sol<sup>♯</sup> si re fa*: this remark will be very useful to us in the sequel.

CHAP. XV. *Of the Preparation of Discords.*

118. In every chord of the seventh, the highest note, that is to say, the seventh above the fundamental, is called a *dissonance* or *discord*; thus *fa* is the dissonance of the chord *sol si re fa*, *ut* in the chord *re fa la ut*, &c.

119. When the chord *sol si re fa* follows the chord *ut mi sol ut*, as this may happen, and in reality often happens, it is obvious that we do not find the dissonance *fa* in the preceding chord *ut mi sol ut*. Nor ought it indeed to be found in that chord; for this dissonance is nothing else but the sub-dominant added to the harmony of the dominant to determine the mode: now, the sub-dominant is not found in the harmony of the generator.

120. For the same reason, when the chord of the sub-

Theory of  
Harmony.

138  
Chords of the seventh continued and explained.

137  
The chords last described, and why.

139  
Dissonance, what.

140  
Manner of preparing dissonances investigated.

(cc) On the contrary, a chord such as *ut mi<sup>b</sup> sol si*, in which *mi* would be flat, could not be admitted in harmony, because in this chord the *si* is not included and understood in *mi<sup>b</sup>*. It is the same case with several other chords, such as *si re fa la<sup>♯</sup>, si re<sup>♯</sup> fa la*, &c. It is true, that in the last of these chords, *la* is included in *fa*, but it is not contained in *re<sup>♯</sup>*; and this *re<sup>♯</sup>* likewise forms with *fa* and with *la* a double dissonance, which, joined with the dissonance *si fa*, would necessarily render this chord not very pleasing to the ear: we shall yet, however, see in the second part, that this chord is sometimes used.

(dd) We have seen above (art 109.) that the chord *si re fa la*, in the minor mode of *la*, may be regarded as the inverse of the chord *re fa la si*: it would likewise seem, that, in certain cases, this chord *si re fa la* may be considered as composed of the two chords *sol si re fa, fa la ut re*, of the dominant and of the sub-dominant of the major mode of *ut*; which chords may be joined together, after having excluded from them, 1. The dominant *sol*, represented by its third major *si*, which is presumed to retain its place. 2. The note *ut* which is understood in *fa*; which will form this chord *si re fa la*. The chord *si re fa la*, considered in this point of view, may be understood as belonging to the major mode of *ut* upon certain occasions.

Theory of sub-dominant *fa la ut re* follows the chord *ut mi sol ut*, the note *re*, which forms a dissonance with *ut*, is not found in the preceding chord.

It is not so when the chord *re fa la ut* follows the chord *ut mi sol ut*; for *ut*, which forms a dissonance in the second chord, stands as a consonance in the preceding.

121. In general, dissonance being the production of art (Chap. xi.), especially in such chords as are not of the tonic dominant nor sub-dominant; it is only to be avoided only means to prevent its displeasing the ear by appearing too heterogeneous to the chord, is, that it may be, if we may speak so, announced to the ear by being found in the preceding chord, and by that means serve to connect the two chords. From whence follows this rule:

122. In every chord of the seventh, which is not the chord of the tonic dominant, that is to say, (art. 102.) which is not composed of a third major followed by two thirds minor, the dissonance which this chord forms ought to stand as a consonance in the chord which precedes it.

This is what we call a *prepared dissonance*. From thence it follows, that in order to prepare a dissonance, it is absolutely necessary that the fundamental bass should ascend by the interval of a second, as

*UT mi sol ut, RE fa la ut;*

or descend by a third, as

*UT mi sol ut, LA ut mi sol;*

or descend by a fifth, as

*UT mi sol ut, FA la ut mi;*

in every other case the dissonance cannot be prepared. This is what may be easily ascertained. If, for instance, the fundamental bass rises by a third, as *ut mi sol ut, mi sol fa re*, the dissonance *re* is not found in the chord *ut mi sol ut*. The same might be said of *ut mi sol ut, sol fa re fa*, and *ut mi sol ut, fa re fa la*, in which the fundamental bass rises by a fifth or descends by a second.

124. It may only be added, that when a tonic, that is to say, a note which carries with it a perfect chord, is followed by a dominant in the interval of a fifth or third, this procedure may be regarded as a process from that same tonic to another, which has been rendered a dominant by the addition of the dissonance.

Moreover, we have seen (art. 119, and 120.) that a dissonance does not stand in need of preparation in the chords of the tonic dominant and of the sub-dominant: from whence it follows, that every tonic carrying with it a perfect chord, may be changed into a tonic dominant (if the perfect chord be major), or into a sub-dominant (whether the chord be major or minor) by adding the dissonance all at once.

CHAP. XVI. Of the Rule for resolving Dissonances.

125. We have seen (Chap. v. and vi.) how the diatonic scale, so natural to the voice, is formed by the harmonics of fundamental sounds; from whence it follows, that the most natural succession of harmonical sounds is to be diatonic. To give a dissonance then, in some measure, as much the character of an harmonic sound as may be possible, it is necessary that

this dissonance, in that part of the modulation where it is found, should descend or rise diatonically upon another note, which may be one of the consonances of the subsequent chord.

126. Now in the chord of the tonic dominant it ought rather to descend than to rise; for this reason. Let us take, for instance, the chord *sol fa re fa* followed by the chord *ut mi sol ut*; the part which formed the dissonance *fa* ought to descend to *mi* rather than rise to *sol*, though both the sounds *mi* and *sol* are found in the subsequent chord *ut mi sol ut*; because it is more natural and more conformed to the connection which ought to be found in every part of the music, that *sol* should be found in the same part where *fa* has already been sounded, whilst the other part was sounding *fa*, as may be here seen (parts first and fourth)

First part,	- - -	<i>fa mi,</i>
Second,	- - -	<i>si ut,</i>
Third,	- - -	<i>re ut,</i>
Fourth,	- - -	<i>sol sol,</i>
Fundamental bass,	- - -	<i>sol ut.</i>

127. For the same reason, in the chord of the sub-dominant *re fa la ut*, followed by *sol fa re fa*, the dissonance *ut* ought rather to descend to *fa* than rise to *re*.

128. In short, for the same reason, we shall find, that in the chord of the sub-dominant *fa la ut re*, the dissonance *re* ought to rise to *mi* of the following chord *ut mi sol ut*, rather than descend to *ut*; whence may be deduced the following rules.

129. 1°. In every chord of the dominant, whether simple or triple, the note which constitutes the seventh, that is to say the dissonance, ought diatonically to descend upon one of the notes which form a consonance in the subsequent chord.

2°. In every chord of the sub-dominant, the dissonance ought to rise diatonically upon the third of the subsequent chord.

130. A dissonance which descends or rises diatonically according to these two rules, is called a *dissonance resolved*.

From these rules it is a necessary result, that the chord of the seventh *re fa la ut*, though one should even consider it as the inverse of *fa la ut re*, cannot be succeeded by the chord *ut mi sol ut*, since there is not in this last chord of *si* any note upon which the dissonance *ut* of the chord *re fa la ut* can descend.

One may besides find another reason for this rule, in examining the nature of the double employment of dissonances. In effect, in order to pass from *re fa la ut*, to *ut mi sol ut*, it is necessary that *re fa la ut*, should in this case be understood as the inverse of *fa la ut re*. Now the chord *re fa la ut*, can only be conceived as the inverse of *fa la ut re*, when this chord *re fa la ut* precedes or immediately follows the *ut mi sol ut*; in every other case the chord *re fa la ut* is a primitive chord, formed from the perfect minor chord *re fa la*, to which the dissonance *ut* was added, to take from *re* the character of a tonic. Thus the chord *re fa la ut*, could not be followed by the chord *ut mi sol ut*, but after having been preceded by the same chord. Now, in this case, the double employment would be entirely a futile expedient, without producing any agreeable effect, because, instead of this succession

143  
Dissonance is only tolerable to the ear when found in preceding chords.

142  
Preparation of dissonances how performed.

See Preparation.

Theory of Harmony.

144  
In the chord of the tonic dominant, the dissonance should rather rise than descend, and why.

145  
Consequence of the former rule.

146  
Another consequence of the dissonance.

147  
But is deduced from the former propositions.

148  
Dissonance resolved, what.

See Resolution.

143  
Dissonances to be resolved, must be disguised and made to appear in the character of harmonics.

Theory of Harmony.

cession of chords, *ut mi sol ut, re fa la ut, ut mi sol ut*, it would be much more easy and natural to substitute this other, which furnishes this natural process, *ut mi sol ut, fa la ut re, ut mi sol ut*. The proper use of the double employment is, that, by means of inverting the chord of the sub-dominant, it may be able to pass from that chord thus inverted, to any other chord except that of the tonic, to which it naturally leads.

CHAP. XVII. Of the Broken or Interrupted Cadence.

The left perfection in cadences to be found in the fundamental bass.

131. In a fundamental base which moves by fifths, there is always, as we have formerly observed (Chap. viii.), a repose more or less perfect from one found to another; and of consequence there must likewise be a repose more or less perfect from one found to another in the diatonic scale, which results from that base. It may be demonstrated by a very simple experiment, that the cause of a repose in melody is solely in the fundamental base expressed or understood. Let any person sing these three notes *ut re ut*, performing on the *re* a shake, which is commonly called a cadence; the modulation will appear to him to be finished after the second *ut*, in such a manner that the ear will neither expect nor wish any thing to follow. The case will be the same if we accompany this modulation with its natural fundamental base *ut sol ut*: but if, instead of that base, we should give it the following, *ut sol la*; in this case the modulation *ut re ut* would not appear to be finished, and the ear would still expect and desire something more. This experiment may easily be made.

Broken cadences, what, and why. See Cadence.

132. This passage *sol la*, when the dominant *sol* diatonically ascends upon the note *la*, instead of descending by a fifth upon the generator *ut*, as it ought naturally to do, is called a broken cadence; because the perfect cadence *sol ut*, which the ear expected after the dominant *sol*, is, if we may speak so, broken and suspended by the transition from *sol* to *la*.

133. From thence it follows, that if the modulation *ut re ut* appeared finished when we supposed no base to it at all, it is because its natural fundamental base *ut sol ut* is supposed to be implied; because the ear desires something to follow this modulation, as soon as it is reduced to the necessity of hearing another base.

Origin of interrupted cadence in the double employment of dissonances.

134. The interrupted cadence may, as it seems to me, be considered as having its origin in the double employment of dissonances; since this cadence, like the double employment, only consists in a diatonic procedure of the base ascending (chap. xii.) In effect, nothing hinders us to descend from the chord *sol si re fa*

to the chord *ut mi sol la*, by converting the tonic *ut* into a sub-dominant, that is to say, by passing all at once from the mode of *ut* to the mode of *sol*: now to descend from *sol si re fa* to *ut mi sol la* is the same thing as to rise from the chord *sol si re fa* to the chord *la ut mi sol*, in changing the chord of the subdominant *ut mi sol la* for the imperfect chord of the dominant, according to the laws of the double employment.

Theory of Harmony.

135. In this kind of cadence, the dissonance of the first chord is resolved by descending diatonically upon the fifth of the subsequent chord. For instance, in the broken cadence *sol si re fa, la ut mi sol*, the dissonance *fa* is resolved by descending diatonically upon the fifth *mi*.

Manner of performing this cadence.

136. There is still another kind of cadence called an interrupted cadence, where the dominant descends by a third to another dominant, instead of descending by a fifth upon the tonic, as in this process of the base, *sol si re fa, mi sol si re*; in the case of an interrupted cadence, the dissonance of the former chord is resolved by descending diatonically upon the octave of the fundamental note of the subsequent chord, as may be here seen, where *fa* is resolved upon the octave of *mi*.

Interrupted cadence, what. See Cadence.

137. This kind of interrupted cadence, as it seems to me, has likewise its origin in the double employment of dissonances. For let us suppose these two chords in succession, *sol si re fa, sol si re mi*, where the note *sol* is successively a tonic dominant and sub-dominant; that is to say, in which we pass from the mode of *ut* to the mode of *re*; if we should change the second of these chords into the chord of the dominant, according to the laws of the double employment, we shall have the interrupted cadence *sol si re fa, mi sol si re*.

Origin of this kind of cadence, likewise in the double employment.

CHAP. XVIII. Of the Chromatic Species.

138. The series or fundamental base by fifths produces the diatonic species in common use (chap. vi.): now the third major being one of the harmonics of a fundamental found as well as the fifth, it follows, that we may form fundamental basses by thirds major, as we have already formed fundamental basses by fifths.

Fundamental bass may be formed by thirds major.

139. If then we should form this base *ut, mi, sol*, the two first sounds carrying each along with it their thirds major and fifths, it is evident that it will give *sol*, and that *mi* will give *sol*: now the semitone which is between this *sol* and this *sol* is an interval much less than the semitone which is found in the diatonic scale between *mi* and *fa*, or between *si* and *ut*. This may be ascertained by calculation (EE); it is for this reason that the semitone from *mi* to *fa* is called major, and the other minor (FF).

A chromatic interval, or minor semitone, how found. See Fig. K.

140. If

(EE) In reality, *ut* being supposed 1 as we have always supposed it, *mi* is  $\frac{2}{3}$ , and *sol*  $\frac{1}{2}$ : now *sol* being  $\frac{1}{2}$ , *sol* then shall be to *sol* as  $\frac{2}{3}$  to  $\frac{1}{2}$ ; that is to say, as 25 times 2 to 3 times 16: the proportion then of *sol* to *sol* is as 25 to 24, an interval much less than that of 16 to 15, which constitutes the semitone from *ut* to *si*, or from *fa* to *mi* (note L).

(FF) It may be observed, that a minor joined to a major semitone, will form a minor tone; that is to say, if one rises, for instance, from *mi* to *fa*, by the interval of a semitone major, and afterwards from *fa* to *fa* by the interval of a minor semitone, the interval from *mi* to *fa* will be a minor tone. For let us suppose *mi* to be 1, *fa* will be  $\frac{15}{12}$ , and *fa* will be  $\frac{15}{12}$ ; that is to say, 25 times 16 divided 24 times 15, or  $\frac{10}{9}$ ; *mi* then is to *fa* as 1 is to  $\frac{10}{9}$ , the interval which constitutes the minor tone (note N).

With respect to the tone major, it cannot be exactly formed by two semitones; for, 1. Two major semitones

in

Theory of  
Harmony.

140. If the fundamental bass should proceed by thirds minor in this manner, *ut, mi*, a succession which is allowed when we have investigated the origin of the minor mode (chap. ix.), we shall find this modulation *sol, sol♯*, which would likewise give a minor semitone (GG).

157  
An intona-  
tion minor  
semitone  
difficult to  
be hit, and  
why.

141. The minor semitone is hit by young practitioners in intonation with more difficulty than the semitone major. For which this reason may be assigned: The semitone major which is found in the diatonic scale, as from *mi* to *fa*; results from a fundamental bass by fifths *ut, fa*, that is to say, by a succession which is most natural, and for this reason the easiest to the ear. On the contrary, the minor semitone arises from a succession by thirds, which is still less natural than the former. Hence, that scholars may truly hit the minor semitone, the following artifice is employed. Let us suppose, for instance, that they intend to rise from *sol* to *sol♯*; they rise at first from *sol* to *la*, then descend from *la* to *sol* by the interval of a semitone major; for this *sol* sharp, which is a semitone major below *la*, proves a semitone minor above *sol*. [See the notes (EF) and (FF).]

158  
Minor femi-  
tone to be  
found in  
every pro-  
cedure of  
the funda-  
mental  
bass by  
thirds.

142. Every procedure of the fundamental bass by thirds, whether major or minor, rising or descending, gives the minor semitone. This we have already seen from the succession of thirds in ascending. The series

in immediate succession would produce more than a tone major. In effect,  $\frac{3}{2} \times \frac{4}{3}$  multiplied by  $\frac{3}{2}$  gives  $\frac{3}{2} \times \frac{3}{2}$ , which is greater than  $\frac{3}{2}$ , the interval which constitutes (note N), the major tone. 2. A semitone minor and a semitone major would give less than a major tone, since they amount only to a true minor. 3. And, *à fortiori*, two minor semitones would give still less.

(GG) In effect, *mi* being  $\frac{2}{3}$ , *sol* being  $\frac{2}{3}$  of  $\frac{2}{3}$ ; that is to say, (note c)  $\frac{2}{3}$ : now the proportion of  $\frac{1}{2}$  to  $\frac{3}{2}$  (note c) is that of 3 times 25 to 2 times 36; that is to say, as 25 to 24.

(HH) *La* being  $\frac{2}{3}$ , *ut* is  $\frac{2}{3}$  of  $\frac{2}{3}$ ; that is to say  $\frac{2}{3}$ , and *ut* is 1: the proportion then between *ut* and *ut* is that of 1 to  $\frac{2}{3}$ , or of 24 to 25.

(II) *La* being the third major below *ut*, will be  $\frac{4}{3}$  (note c): *ut*, then, is  $\frac{4}{3}$  of  $\frac{4}{3}$ ; that is to say  $\frac{4}{3}$ . The proportion, then, between *ut* and *ut* is as 25 to 24.

(LL) *Sol* being  $\frac{2}{3}$ , and *si* being  $\frac{2}{3}$  of  $\frac{2}{3}$ , we shall have *si* equal (note c) to  $\frac{1}{2} \times \frac{2}{3}$ , and its octave below shall be  $\frac{1}{2} \times \frac{2}{3}$ ; an interval less than unity by about  $\frac{1}{24}$  or  $\frac{1}{37}$ . It is plain then from this fraction, that the *si* in question must be considerably lower than *ut*.

This interval has been called the *fourth of a tone*, and this denomination is founded on reason. In effect, we may distinguish in music four kinds of quarter tones.

1. The fourth of a tone major: now, a tone major being  $\frac{9}{8}$ , and its difference from unity being  $\frac{1}{8}$ , the difference of this quarter tone from unity will be almost the fourth of  $\frac{1}{8}$ ; that is to say,  $\frac{1}{32}$ .

2. The fourth of a tone minor; and as a tone minor, which is  $\frac{8}{7}$ , differs from unity by  $\frac{1}{7}$ , the fourth of a minor tone will differ from unity about  $\frac{1}{28}$ .

3. One half of a tone major; and as this semitone differs from unity by  $\frac{1}{4}$ , one half of it will differ from unity about  $\frac{1}{8}$ .

4. Finally, one half of a semitone minor, which differs from unity by  $\frac{1}{8}$ : its half then will be  $\frac{1}{16}$ .

The interval, then, which forms the enharmonic fourth of a tone, as it does not differ from unity but by  $\frac{1}{32}$ , may justly be called the *fourth of a tone*, since it is less different from unity than the largest interval of a quarter tone, and more than the least.

We shall add, that since the enharmonic fourth of a tone is the difference between a semitone major and a semitone minor; and since the tone minor is formed (note FF) of two semitones, one major and the other minor; it follows, that two semitones major in succession form an interval larger than that of a tone by the enharmonic fourth of a tone; and that two minor semitones in succession form an interval less than a tone by the same fourth of a tone.

(MM) That is to say, that if you rise from *mi* to *fa*, for instance, by the interval of a semitone major, and afterwards, returning to *mi*, you should rise by the interval of a semitone minor to another found which is not in the scale, and which I shall mark thus, *fa+*, the two sounds *fa+* and *fa* will form the enharmonic fourth of a tone: for *mi* being 1, *fa* will be  $\frac{9}{8}$ ; and *fa+*  $\frac{9}{8}$ : the proportion then between *fa+* and *fa* is that of  $\frac{9}{8}$  to  $\frac{9}{8}$  (note c); that is to say, as 25 times 15 to 16 times 24; or otherwise, as 25 times 5 to 16 times 8, or as 125 to 128. Now this proportion is the same which is found, in the beginning of the preceding note, to express the enharmonic fourth of a tone.

of thirds minor in descending, *ut, la*, gives *ut, ut* (HH); and the series of thirds major in descending, *ut, la*, gives *ut, ut* (II).

143. The minor semitone constitutes the species called *chromatic*; and with the species which moves by semitone diatonic intervals, resulting from the succession of fifths (chap. v. and vi.), it comprehends the whole of melody.

### CHAP. XIX. Of the Enharmonic Species.

144. THE two extremes, or highest and lowest notes, of the fundamental bass by thirds major, *ut, mi, sol*, give this modulation *ut, si*; and these two sounds *ut, si*, differ between themselves by a small interval which is called the *diésis*, or *enharmonic fourth* formed of a tone (LL), which is the difference between a semitone major and a semitone minor (MM). This quarter tone is inappreciable by the ear, and impracticable upon several of our instruments. Yet have means been found to put it in practice in the following manner, or rather to perform what will have the same effect upon the ear.

145. We have explained (art. 116.) in what manner the chord *sol, si, re, fa* may be introduced into the minor mode, entirely consisting of thirds minor perfectly true, or at least supposed such. This chord supplanting the place of the chord of the dominant (art. 116.)

Theory of  
Harmony.

159  
The minor  
semitone  
when pre-  
valent,  
constitutes  
chromatic  
music.

160  
Difles or  
enharmonic  
interval,  
what,  
and how  
formed.  
\* See Fourth  
of a Tone.

161  
Manner of  
seemingly  
introducing  
this interval  
upon instru-  
ments  
of fixed  
scales.

Theory of Harmony.

Theory of Harmony.

116.) from thence we may pass to that of the tonic or generator *fa* (art. 117.). But we must remark,

1. That this chord *sol*%, *fi re fa*, entirely consisting of thirds minor, may be inverted or modified according to the three following arrangements, *fi re fa sol*%, *re fa sol*%, *fa sol*%, *fi re*; and that in all these three different states, it will still remain composed of thirds minor; or at least there will only be wanting the enharmonic fourth of a tone to render the third minor between *fa* and *sol*%, entirely just; for a true third minor, as that from *mi* to *sol* in the diatonic scale, is composed of a semitone and a tone both major. Now from *fa* to *sol* there is a tone major, and from *sol* to *sol*%, there is only a minor semitone. There is then wanting (art. 144.) the enharmonic fourth of a tone, to render the third *fa sol*%, exactly true.

2. But as this division of a tone cannot be found in the gradations of any scale practicable upon most of our instruments, nor be appreciated by the ear, the ear takes the different chords,

*fi re fa sol*%,  
*re fa sol*%,  
*fa sol*%,  
*fi re*,

which are absolutely the same, for chords composed every one of thirds minor exactly just.

Now the chord *sol*%, *fi re fa*, belonging to the minor mode of *la*, where *sol*%, is the sensible note; the chord *fi re fa sol*%, or *fi re fa lab*, will, for the same reason, belong to the minor mode of *ut*, where *fi* is the sensible note. In like manner, the chord *re fa sol*%, *fi*, or *fi re fa lab ut*, will belong to the minor mode of *mi*, and the chord *fa sol*%, *fi re*, or *fa lab ut mi*, to the minor mode of *sol*.

After having passed then by the mode of *la* to the chord *sol*%, *fi re fa* (art. 117.), one may by means of this last chord, and by merely satisfying ourselves to invert it, afterwards pass all at once to the modes of *ut* minor, of *mi* minor, or of *sol* minor; that is to say, into the modes which have nothing, or almost nothing, in common with the minor mode of *la*, and which are entirely foreign to it (†).

162. 146. It must, however, be acknowledged, that a transition so abrupt, and so little expected, cannot deceive nor elude the ear; it is struck with a sensation so unlooked-for without being able to account for the passage to itself. And this account has its foundation

in the enharmonic fourth of a tone; which is overlooked as nothing, because it is inappreciable by the ear; but of which, tho' its value is not ascertained, the whole harshness is sensibly perceived. The instant of surprise, however, immediately vanishes; and that astonishment is turned into admiration, when one feels himself transported as it were all at once, and almost imperceptibly, from one mode to another, which is by no means relative to it, and to which he never could have immediately passed by the ordinary series of fundamental notes.

CHAP. XX. Of the Diatonic Enharmonic Species.

147. If we form a fundamental bass, which rises alternately by fifths and thirds, as *fa, ut, mi, fi*, this bass will give the following modulation, *fa, mi, mi*, See fig. M. *re*%; in which the semitones from *fa* to *mi*, and from *mi* to *re*%, are equal and major (NN).

This species of modulation or of harmony, in which all the semitones are major, is called the *enharmonic diatonic* species. The major semitones peculiar to this species give it the name of *diatonic*, because major semitones belong to the diatonic species; and the tones which are greater than major by the excess of a fourth, resulting from a succession of major semitones, give it the name of *enharmonic* (note LL).

See Enharmonic.

CHAP. XXI. Of the Chromatic Enharmonic Species.

148. If we pass alternately from a third minor in descending to a third major in rising, as *ut, ut, la, ni* inter-*ut*%, *ut*%, we shall find this modulation *mi*%, *mi*, *ni*, *ni*%, in which all the semitones are minor (oo). See fig. N.

This species is called the *chromatic enharmonic* species: the minor semitones peculiar to this kind give it the name of *chromatic*, because minor semitones belong to the chromatic species; and the semitones which are lesser by the diminution of a fourth resulting from a succession of minor semitones, give it the name of *enharmonic* (note LL).

163 Chromatic enharmonic intervals, how formed.

149. These new species confirm what we have all along said, that the whole effects of harmony and melody reside in the fundamental bass.

164 From this species, the effects of harmony and melody appear to be in the fundamental bass.

150. The diatonic species is the most agreeable, be-

165 Diatonic species most agreeable, and why.

(†) As this method for obtaining or supplying enharmonic gradations cannot be practised on every occasion when the composer or practitioner would wish to find them, especially upon instruments where the scale is fixed and invariable, except by a total alteration of their economy, and re-tuning the strings, Dr Smith in his Harmonics has proposed an expedient for redressing or qualifying this defect, by the addition of a greater number of keys or strings, which may divide the tone or semitone into as many appreciable or sensible intervals as may be necessary. For this, as well as for the other advantageous improvements which he proposes in the structure of instruments, we cannot with too much warmth recommend the perusal of his learned and ingenious book to such of our readers as aspire to the character of genuine adepts in the theory of music.

(NN) It is obvious, that if *fa* in the bass be supposed 1, *fa* of the scale will be 2, *ut* of the bass  $\frac{1}{2}$ , and *mi* of the scale  $\frac{1}{2}$  of  $\frac{1}{2}$ , that is,  $\frac{1}{4}$ ; the proportion of *fa* to *mi* is as 2 to  $\frac{1}{4}$ , or as 1 to  $\frac{1}{8}$ . Now *mi* of the bass being likewise  $\frac{1}{2}$  of  $\frac{1}{2}$ , or  $\frac{1}{4}$ , *fi* of the bass is  $\frac{1}{2}$  of  $\frac{1}{4}$ , and its third major *re*%,  $\frac{1}{2}$  of  $\frac{1}{4}$  of  $\frac{1}{4}$ , or  $\frac{1}{8}$  of  $\frac{1}{4}$ ; this third major, approximated as much as possible to *mi* in the scale by means of octaves, will be  $\frac{1}{8}$  of  $\frac{1}{4}$ : *mi* then of the scale will be to *re*%, which follows it, as  $\frac{1}{8}$  is to  $\frac{1}{8}$  of  $\frac{1}{4}$ , that is to say, as 1 to  $\frac{1}{8}$ . The semitones then from *fa* to *mi*, and from *mi* to *re*%, are both major.

(oo) It is evident that *mi* is  $\frac{1}{2}$  (note c), and that *mi* is  $\frac{1}{4}$ : these two *mi*'s, then, are between themselves as  $\frac{1}{2}$  to  $\frac{1}{4}$ , that is to say, as 6 times 4 to 5 times 5, or as 24 to 25, the interval which constitutes the minor semitone. Moreover, the *la* of the bass is  $\frac{1}{2}$ , and *ut*%,  $\frac{1}{2}$  of  $\frac{1}{2}$ , or  $\frac{1}{4}$ : *mi*%, then is  $\frac{1}{2}$  of  $\frac{1}{4}$ , the *mi* in the scale is likewise to the *mi*%, which follows it, as 24 to 25. All the semitones therefore in this scale are minor.

162 The alteration, however, by which it is effluated, abrupt and sensible.



<sup>164</sup> Theory of Harmony. because the fundamental bass which produces it is formed from a succession of fifths alone, which is the most natural of all others.

<sup>166</sup> The chromatic next. 151. The chromatic being formed from a succession of thirds, is the most natural after the preceding.

<sup>167</sup> Lastly, the enharmonic. 152. Finally, the enharmonic is the least agreeable of all, because the fundamental bass which gives it is not immediately indicated by nature. The fourth of a tone which constitutes this species, and which is itself inappreciable to the ear, neither produces nor can produce its effect, but in proportion as imagination suggests the fundamental bass from whence it results; a bass whose procedure is not agreeable to nature, since it is formed of two sounds which are not contiguous one to the other in the series of thirds (art. 144.)

CHAP. XXII. *Showing that Melody is the Offspring of Harmony.*

<sup>168</sup> The effects of melody to be investigated in harmony expressed or understood. 153. ALL that we have hitherto said, as it seems to me, is more than sufficient to convince us, that melody has its original principle in harmony; and that it is in harmony, expressed or understood, that we ought to look for the effects of melody.

154. If this should still appear doubtful, nothing more is necessary than to pay due attention to the first experiment (art. 19.), where it may be seen that the principal sound is always the lowest, and that the sharper sounds which it generates are with relation to it what the treble of an air is to its bass.

155. Yet more, we have proved, in treating of broken cadence (Chap. xvii.), that the diversification of basses produces effects totally different in a modulation which, in other respects, remains the same.

156. Can it be still necessary to adduce more convincing proofs? We have nothing to do but examine the different basses which may be given to this very simple modulation *sol ut*; of which it will be found susceptible of a great many, and each of these basses will give a different character to the modulation *sol ut*, though in itself it remains always the same; in such a manner that we may change the whole nature and effects of a modulation, without any other alteration except that of changing its fundamental bass.

M. Rameau has shown, in his *New System of Music*, printed at Paris 1726, p. 44. that this modulation *sol*

*ut*, is susceptible of 20 different fundamental basses. Now the same fundamental bass, as may be seen in our second part, will afford several continued or thorough basses. How many means, of consequence, may be practised to vary the expression of the same modulation?

<sup>169</sup> Consequences deducible from this principle. 157. From these different observations it may be concluded, 1. That an agreeable melody, naturally implies a bass extremely sweet and adapted for singing; and that reciprocally, as musicians express it, a bass of this kind generally prognosticates an agreeable melody (pp).

2. That the character of a just harmony is only to form in some measure one system with the modulation, so that from the whole taken together the ear may only receive, if we may speak so, one simple and indivisible impression.

3. That the character of the same modulation may be diversified, according to the character of the bass which is joined with it.

But notwithstanding the dependency of melody upon harmony, and the sensible influence which the latter may exert upon the former; we must not however from thence conclude, with some celebrated musicians, that the effects of harmony are preferable to those of melody. Experience proves the contrary. [See, on this account, what is written on the licence of music, printed in tom. iv. of D'Alembert's *Melanges de Littérature*, p. 448.]

GENERAL REMARK.

THE diatonic scale or gammut being composed of twelve semitones, it is clear that each of these semitones taken by itself may be the generator of a mode; and that thus there must be twenty-four modes in all, twelve major and twelve minor. We have assumed the major mode of *ut*, to represent all the major modes in general, and the minor mode of *la* to represent the modes minor, to avoid the difficulties arising from sharps and flats, of which we must have encountered either a greater or lesser number in the other modes. But the rules we have given for each mode are general, whatever note of the gammut be taken for the generator of a mode.

PART II. PRINCIPLES and RULES OF COMPOSITION.

<sup>170</sup> Composition in harmony, what. See Composition. 158. COMPOSITION, which is likewise called counterpoint, is not only the art of composing an agreeable air, but also that of composing a great many airs in such a manner that when heard at the same time, they may unite in producing an effect agreeable and delightful to the ear; this is what we call *composing music in several parts*.

The highest of these parts is called the *treble*, the lowest is termed the *bass*; the other parts, when there are any, are termed *middle parts*; and each in particular is signified by a different name.

I

CHAP. I. *Of the Different Names given to the same Interval.*

159. In the introduction (art. 9.), which is at the front of this treatise, we have given a detail of the most common names which are given to the different intervals. But there are particular intervals which have obtained different names, according to particular circumstances; which it is proper to explain.

160. An interval composed of a tone and a semi-tone, which is commonly called a *third minor*, is likewise called a *third major*.

[ f ]

171 Particular intervals signified by different names, and 172 Second redundant wife what.

(pp) There are likewise several eminent musicians, who in their compositions, if we can depend on what has been affirmed, begin with determining and writing the bass. See *l'Encyclopédie*, tom. 7. p. 61. This method, however, appears in general more proper to produce a learned and harmonious music, than a strain prompted by genius and animated by enthusiasm.

Principles of Composition.

wife sometimes called a *second redundant*; such is the interval from *ut* to *re* in ascending, or that of *la* to *sol* descending.

173 Why so called.

This interval is so termed, because one of the sounds which form it is always either sharp or flat, and that, if you deduce that sharp or that flat, the interval will be that of a second.

174 False fifth, what.

161. An interval composed of two tones and two semitones, as that from *si* to *fa*, is called a *false fifth*. This interval is the same with the *triton* (art. 9.), since two tones and two semitones are equivalent to three tones. There are, however, some reasons for distinguishing them, as will appear below.

175 Fifth redundant, what.

162. As the interval from *ut* to *re* in ascending, has been called a *second redundant*, they likewise call the interval from *ut* to *sol* in ascending a *fifth redundant*, or from *si* to *mi* in descending, each of which intervals are composed of four tones.

176 Distinguished from the sixth minor.

This interval is, in the main, the same with that of the sixth minor (art. 9.): but in the fifth redundant there is always a sharp or a flat; inasmuch, that if this sharp or flat were deduced, the interval would become a true fifth.

177 Seventh diminished, what.

163. For the same reason, an interval composed of three tones and three semitones, as from *sol* to *fa* in ascending, is called a *seventh diminished*; because, if you deduced the sharp from *sol*, the interval from *sol* to *fa* will become that of an ordinary seventh. The interval of a seventh diminished is in other respects the same with that of the sixth major (art. 9.)

178 Seventh major and redundant coincident.

164. The major seventh is likewise sometimes called a *seventh redundant* (QQ.)

179 Notes in different octaves or scales replications each of the other.

CHAP. II. Comparison of the Different Intervals.

165. If we sing *ut si* in descending by a second, and afterwards *ut si* in ascending by a seventh, these two *si*'s shall be octaves one to the other; or, as we commonly express it, they will be *replications* one of the other.

180 Hence to descend to one replication, and rise to another, has the same effect.

166. On account then of the resemblance between every sound and its octave (art. 22.), it follows, that to rise by a seventh, or descend by a second, amount to one and the same thing.

167. In like manner, it is evident that the sixth is nothing but a replication of the third, nor the fourth but a replication of the fifth.

181 Detail of replications.

168. The following expressions either are, or ought

(QQ.) The chief use of these different denominations is to distinguish chords: for instance, the chord of the redundant fifth and that of the diminished seventh, are different from the chord of the sixth; the chord of the seventh redundant from that of the seventh major. This will be explained in the following chapters.

(RR.) It is on account of the different compasses of voices and instruments that these clefs have been invented. The masculine voice, which is the lowest, may at its greatest depth, without straining, descend to *sol*, which is in the last line of the first clef of *fa*; and the female voice, which is the sharpest, may at its highest pitch rise to a *sol*, which is a triple octave above the former.

The lowest of masculine voices is adapted to a part which may be called a *mean bass*, and its clef is that of *fa* on the fourth line; this clef is likewise that of the violoncello and of the deepest instruments. A mean bass extremely deep is called a *baritone* or *counter-bass*.

The masculine voice, which is next in depth to what we have called the *mean bass*, may be termed the *concordant bass*. Its clef is that of *fa* on the third line.

The masculine voice which follows the *concordant bass* may be denominated a *tenor*; a voice of this pitch is the most common, yet seldom extremely agreeable. Its clef is that of *ut* on the fourth line. This clef is also that of the bassoon or *bass hautboy*.




The highest masculine voice of all may be called *counter tenor*. Its clef is that of *ut* on the third line. It is likewise the clef of tenor violins, &c.



to be, regarded as synonymous.



To rise	by a second.	To descend	by a seventh.
To descend	To rise	To rise	by a sixth.
To rise	by a third.	To descend	by a fifth.
To descend	To rise	To rise	by a fourth.
To rise	by a fourth.	To descend	by a fifth.
To descend	To rise		

169. Thus, therefore, we shall employ them indifferently the one for the other; so that when we say, for instance, to rise by a third, it may be said with equal propriety to descend by a sixth, &c.

CHAP. III. Of the different Clefs; of the Value or Quantity; of the Rithmus; and of Syncopation.

170. THERE are three clefs in music: the clef of *fa* , or ; the clef of *ut* ; and the clef of

*fa* . But, in Britain, the following characters are used: The F, or bass-clef ; the C, or tenor

clef ; and the G, or treble clef 

The clef of *fa* is placed on the fourth line, the third; and the line upon which this clef is placed gives the name of *fa*, or *F*, to all the notes which are upon that line.

The clef of *ut* is placed upon the fourth, the third, the second, or the first line; and in these different positions all the notes upon that line where the clef is placed take the name of *ut*, or *C*.

Lastly, the clef of *sol* is placed upon the second or first line; and all the notes upon that line where the clef is placed take the name of *sol*, or *G*.

171. As the notes are placed on the lines, and in the spaces between the lines, any one, when he sees the clef, may easily find the name of any note whatever. Thus he may see, that, in the first clef of *fa*, the note which is placed on the lowest line ought to be *sol*; that the note which occupies the space between the two first lines should be *la*; and that the note which is on the second line is a *si*, &c. (RR.)

172. A

Principles of Composition.

182 Examples of this.

183 Clef, what.

184 And how placed. See fig. O.

See fig. P.

See fig. Q.

185 Names of notes to be investigated from the position of the clefs. See fig. O.

Principles  
of Composi-  
tion.186  
Marks and  
powers of  
sharps, flats  
and natu-  
rals, & hat.

See fig. R.

See fig. S.

See fig. X.

187  
Bars and  
times, &  
what.

See Time.

172. A note before which there is a sharp (marked thus ♯) ought to be raised by a semitone; and if, on the contrary, there is a ♭ before it, it ought to be depressed by a semitone, (♭ being the mark of a flat).

The natural (marked thus ♮) restores to its natural value a note which had been raised or depressed by a semitone.

173. When you place at the cleff a sharp or a flat, all the notes upon the line on which this sharp or flat is marked are sharp or flat. Thus let us take, for instance, the cleff of *ut* upon the first line, and let us place a sharp in the space between the second and third line, which is the place of *fa*; all the notes which shall be marked in that space will be *fa*♯; and if you would restore them to their original value of *fa* natural, you must place a ♯ or a ♭ before them.

In the same manner, if a flat be marked at the cleff, and if you would restore the note to its natural state, you must place a ♯ or a ♮ before it.

174. Every piece of music is divided into different equal times, which they call *measures* or *bars*; and each bar is likewise divided into different times.

There are properly two kinds of measures or modes of time (See I): the measure of two times, or of common time, which is marked by the figure 2 placed at the beginning of the tune; and the measure of

three times, or of triple time, which is marked by the figure 3 placed in the same manner. (See V.)

The different bars are distinguished by perpendicular lines.

In a bar we distinguish between the *perfect* and *imperfect* time; the *perfect* time is that which we *beat*, the *imperfect* that in which we *lift up the hand or foot*. A bar consisting of four times ought to be regarded as compounded of two bars, each consisting of two times: thus there are in this bar two perfect and two imperfect times. In general, by the words *perfect* and *imperfect*, even the parts of the same time are distinguished: thus the first note of each time is reckoned as belonging to the *perfect* part, and the others as belonging to the *imperfect*.

175. The longest of all notes is a semibreve. A The value of notes in duration.  
minim is half its value; that is to say, in singing, we only employ the same duration in performing two minims which was occupied in one semibreve. A minim in the same manner is equivalent to two crotchets, the crochets to two quavers, &c.

176. A note which is divided into two parts by a time, that is to say, which begins at the end of a time, what.  
time, and terminates in the time following, is called (ss) a *syncopated note*. (See Z; where the notes *ut*, *fa*, and *la*, are each of them syncopated.) (†).  
[f 2] 177. A

The deepest female voice immediately follows the counter tenor, and may be called *bass* in *alt*. Its cleff is that of *ut* upon the first line. The cleff of *ut* upon the second line is not in frequent use.

The sharpest female voice is called *treble*; its cleff is that of *sol* on the second line.

This last cleff, as well as that of *sol* on the first line, is likewise the cleff of the sharpest instruments, such as the violin, the flute, the trumpet, the hautboy, the flagelet, &c.

The *ut* which may be seen in the cleffs of *fa* and in the cleffs of *ut* is a fifth above the *fa* which is on the line of the cleff of *fa*; and the *sol* which is on the two cleffs of *sol* is a fifth above *ut*: inasmuch that *sol* which is on the lowest line of the first cleff of *fa*, is lower by two whole octaves than the *sol* which is on the lowest line of the second cleff of *sol*.

[Thus far the translator has followed his original as accurately as possible; but this was by no means an easy task. Among all the writers on music which he has found in English, there is no such thing as different names for each particular part which is employed to constitute full or complete harmony. He was therefore under a necessity of substituting by analogy such names as appeared most expressive of his author's meaning. To facilitate this attempt, he examined in Rousseau's musical dictionary the terms by which the different parts were denominated in D'Alembert; but even Rousseau, with all his depth of thought and extent of erudition, instead of expressing himself with that precision which the subject required, frequently applies the same names indiscriminately to different parts, without assigning any reason for this promiscuous and licentious use of words. The English reader therefore will be best able to form an accurate idea of the different parts, by the nature and situation of the cleffs with which they are marked; and if he should find any impropriety in the names which are given them, he may adopt and affixate others more agreeable to his ideas.]

(ss) Syncopation consists in a note which is protracted in two different times belonging partly to the one and partly to the other, or in two different bars; yet not so as entirely to occupy or fill up the two times, or the two bars. A note, for instance, which begins in the imperfect time of a bar, and which ends in the perfect time of the following, or which in the same bar begins in the imperfect part of one time and ends in the perfect of the following, is syncopated. A note which of itself occupies one or two bars, whether the measure consists of two or three times, is not considered as syncopated: this is a consequence of the preceding definition. This note is said to be *continued* or *protracted*. In the end of the example Z, the *ut* of the first bar consisting of three times is not syncopated, because it occupies two whole times. It is the same case with *mi* of the second bar, and with the *ut* of the fourth and fifth. These therefore are continued or protracted notes.

(†) *Times* and *bars* in music answer the very same end as punctuation in language. They determine the different periods of the movement, or the various degree of completion, which the sentiment, expressed by that movement, has attained. Let us suppose, for instance, a composer in music intending to express grief or joy, in all its various gradations, from its first and faintest sensation, to its acme or highest possible degree. We do not say that such a progress of any passion either has been or can be delineated in practice, yet it may serve to illustrate that we mean to explain. Upon this hypothesis, therefore, the degrees of the sentiment will pass from less to more sensible, as it rises to its most intense degree. The first of these gradations may be called a

Principles  
of Composi-  
tion.

See fig. Y.

188  
of notes in  
duration.189  
Syncopa-  
tion, what.  
See Syncopa-  
tion.

Principles of Composition.

Value of a pointed note.

191 Perfect chords, what.

192 Chord of the seventh, what, and how to be practised.

193 Thote of different kinds.

194 Of the greater sixth, what.

177. A note followed by a point or dot is increased half its value. The *fi*, for instance, in the fifth bar of the example Y, followed by a point, has the value (\*) or duration of a minim and of a crotchet at the same time.

CHAP. IV. Containing a Definition of the principal Chords.

178. THE chord composed of a third, a fifth, and an octave, as *ut mi sol ut*, is called a *perfect chord* (art. 32).

If the third be major, as in *ut mi sol ut*, the perfect chord is denominated *major*: if the third be minor, as in *la ut mi la*, the perfect chord is minor. The perfect chord major constitutes what we call the *major mode*; and the perfect chord minor, what we term the *minor mode* (art. 31).

179. A chord composed of a third, a fifth, and a seventh, as *sol si re fa*, or *re fa la ut*, &c. is called a *chord of the seventh*. It is obvious that such a chord is wholly composed of thirds in ascending.

All chords of the seventh are practised in harmony, save that which might carry the third minor and the seventh major, as *ut mi<sup>b</sup> sol si*; and that which might carry a false fifth and a seventh major, as *si re fa la<sup>♯</sup>*. (chap. xiv. Part I.)

180. As thirds are either major or minor, and as they may be differently arranged, it is clear that there are several kinds of chords of the seventh; there is even one, *si re fa la*, which is composed of a third, a false fifth, and a seventh.

181. A chord composed of a third, a fifth, and a sixth, as *fa la ut re*, *re fa la si*, is called a *chord of the*

*greater sixth*.

182. Every note which carries a perfect chord is called a *tonic*, and the perfect chord is marked by an 8, by a 3, or by a 5, which is written above the note; but frequently these numbers are suppressed. Thus in the example I. the two *ut*'s equally carry a perfect chord.

183. Every note which carries a chord of the seventh is called a *dominant* (art. 102); and this chord is marked by a 7 written above the note. Thus in the example II. *re* carries the chord *re fa la ut*, and *sol* the chord *sol si re fa*.

It is necessary to remark, that among the chords of the seventh we do not reckon the chord of the seventh diminished, which is only improperly called a *chord of the seventh*: and of which we shall say more below.

184. Every note which carries the chord of the great sixth, is called a *sub-dominant*, (art 97, and 42.) and is marked with a 6. Thus in the example III. *fa* carries the chord of *fa la ut re*. You ought to remark that the sixth should always be major, (art. 97, and 109).

185. In every chord, whether perfect, or a chord of the seventh, or of the great sixth, the note which carries this chord, and which is the flattest or lowest, is called the *fundamental note*. Thus *ut* in the example I. *re* and *sol* in the example II. and *fa* in the example III. are fundamental notes.

186. In every chord of the seventh, and of the great sixth, the note which forms the seventh or sixth above the fundamental, that is to say, the highest note of the chord, is called a *dissonance*. Thus in the chords

Principles of Composition.

195 Tonic, what, and its chords, how figured.

196 Dominant, what, and how figured.

197 Sub-dominant, what, and how figured.

198 Fundamental note, what.

199 Dissonance of a chord, what.

*time*, which is likewise the most convenient division of a bar or measure into its elementary or aliquot parts, and may be deemed equivalent to a comma in a sentence; a bar denotes a degree still more sensible, and may be considered as having the force of a semicolon; a strain brings the sentiment to a tolerable degree of perfection, and may be reckoned equal to a colon: the full period is the end of the imitative piece. It must have been remarked by observers of measure in melody or harmony, that the notes of which a bar or measure consists, are not diversified by their different durations alone, but likewise by greater or lesser degrees of emphasis. The most emphatic parts of a bar are called the *accented parts*; those which require less energy in expression are called the *unaccented*. The same observation holds with regard to times as bars. The stroke, therefore, of the hand or foot in beating marks the accented part of the bar, the elevation or preparation for the stroke marks the unaccented part. Let us once more resume our composition intended to express the different periods in the progress of grief or joy. There are some revolutions in each of these so rapid as not to be marked by any sensible transition whether diatonic or consonant. In this case, the most expressive tone may be continued from one part of a time or measure to another, and end before the period of that time or measure in which it begins. Here therefore is a natural principle upon which the practice of syncopation may be founded even in melody: but when music is composed in different parts to be simultaneously heard, the continuance of one note not divided by regular times and measures, nor beginning and ending with either of them, whilst the other parts either ascend or descend according to the regular divisions of the movement, has not only a sensible effect in rendering the imitation more perfect, but even gives the happiest opportunities of diversifying the harmony, which of itself is a most delightful perception.

For the various dispositions of accent in times and measures, according to the movement of any piece, see a Treatise on Music by Alexander Malcolm.

For the opportunities of diversifying harmony afforded by syncopation, see Rameau's Principles of Composition.

(\*) To prevent ambiguity or confusion of ideas, it is necessary to inform our readers, that we have followed M. D'Alembert in his double sense of the word *value*, though we could have wished he had distinguished the different meanings by different words. A found may be either estimated by its different degrees of intensity, or by its different quantities of duration.

To signify both those ideas the word *value* is employed by D'Alembert. The reader, therefore, will find it of importance to distinguish the value of a note in height from its value in duration. This he may easily do, by considering whether the notes are treated as parts of the diatonic scale, or as continued for a greater or lesser duration.

Principles  
of Compo-  
sition.

chords of the seventh *sol fa re fa, re fa la ut, fa* and *ut* are the dissonances, viz. *fa* with relation to *sol* in the first chord, and *ut* with relation to *re* in the second. In the chord of the great sixth *fa la ut re, re* is the dissonance (art. 120.); but that *re* is only, properly speaking, a dissonance with relation to *ut* from which it is a *second*, and not with respect to *fa* from which it is a *sixth major* (art. 17, and 18).

Tonic and  
simple do-  
minant,  
what.

187. When a chord of the seventh is composed of a third major followed by two thirds minor, the fundamental note of this chord is called the *tonic dominant*. In every other chord of the seventh the fundamental is called the *simple dominant*, (art. 102.) Thus in the chord *sol fa re fa*, the fundamental *sol* is the *tonic dominant*; but in the other chords of the seventh, as *ut mi sol fi, re fa la ut*, &c. the fundamentals *ut* and *re* are *simple dominants*.

207  
Major  
chords,  
how ren-  
dered mi-  
nor, and  
vice versa.

188. In every chord, whether perfect, or of the seventh, or of the sixth, if you have a mind that the third above the fundamental note should be major, though it is naturally minor, you must place a sharp above the fundamental note. For example, if I would mark the perfect major chord *re fa la re*, as the third *fa* above *re* is naturally minor, I place above *re* a sharp, as you may see in example IV. In the same manner the chord of the seventh *re fa la ut*, and the chord of the great sixth *re fa la fi*, is marked with a  $\sharp$  above *re*, and above the  $\sharp$  a 7 or a 6, (see V. and VI.)

On the contrary, when the third is naturally major, and if you should incline to render it minor, you must place above the fundamental note a  $\flat$ . Thus the examples VII. VIII. IX. shew the chords *sol fi re sol, sol fi re fa, sol fi re mi*, (TR).

#### CHAP. V. Of the Fundamental Bass.

202  
Fundamen-  
tal bass,  
how form-  
ed.

189. INVENT a modulation at your pleasure; and under this modulation let there be set a bass composed of different notes, of which some may carry a perfect chord, others that of the seventh, and others that of the great sixth, in such a manner that each note of the modulation which answers to each of the bass, may

be one of those which enters into the chord of that note in the bass; this bass being composed according to the rules which shall be immediately given, will be the *fundamental bass* of the modulation proposed. See *Funda-* Part I. where the *nature and principles of the funda-* mental bass are explained. Principles  
of Compo-  
sition.

Thus (Exam. XVIII.) you will find that this modulation, *ut re mi fa sol la fi ut*, has or may admit for its fundamental bass, *ut sol ut fa ut re sol ut*.

In reality, the first note *ut* in the upper-part is found in the chord of the first note *ut* in the bass, which chord is *ut mi sol ut*; the second note *re* in the treble is found in the chord *sol fi re fa*, which is the chord of the second note in the bass, &c. and the bass is composed only of notes which carry a perfect chord, or that of the seventh, or that of the great sixth. Moreover, it is formed according to the rules which we are now about to give.

#### CHAP. VI. Rules for the Fundamental Bass.

190. ALL the notes of the fundamental bass being only capable of carrying a perfect chord, or the chord of the seventh, or that of the great sixth, are either tonics, or dominants, or sub-dominants; and the dominants may be either simple or tonic. 203  
Rules for  
the forma-  
tion of this  
bass.

The fundamental bass ought always to begin with a tonic, as much as it is practicable. And now follow the rules for all the succeeding chords; rules which are evidently derived from the principles established in the *First Part* of this treatise. To be convinced of this, we shall find it only necessary to review the articles 34, 91, 122, 124, 126, 127.

#### RULE I.

191. In every chord of the tonic, or of the tonic dominant, it is necessary that at least one of the notes which form that chord should be found in the chord that precedes it.

#### RULE II.

192. In every chord of the simple dominant, it is necessary that the note which constitutes the seventh, or

(TR) We may only add, that there is no occasion for marking these sharps or flats when they are originally placed at the cleff. For instance, if the sharp be upon the cleff of *fa* (see Exam. X.), one may satisfy himself with simply writing *re*, without a sharp to mark the perfect chord major of *re, re fa la re*. In the same manner, in the Example XI. where the flat is at the cleff upon *fi*, one may satisfy himself with simply writing *sol*, to mark the perfect chord minor of *sol fi re sol*.

But if a case occurs where there is a sharp or a flat at the cleff, if any one should wish to render the chord minor which is major, or *vice versa*, he must place above the fundamental note a  $\sharp$  or natural. Thus the Example XII. marks the minor chord *re fa la re*, and Example XIII. the major chord *sol fi re sol*.—Frequently, in lieu of a natural, a flat is used to signify the minor chord, and a sharp to signify the major. Thus Example XIV. marks the minor chord *re fa la re*, and Example XV. the major chord *sol fi re sol*.

When in a chord of the great sixth, the dissonance, that is to say, the sixth, ought to be sharp, and when the sharp is not found at the cleff, they write before or after the 6 a  $\sharp$ ; and if this sixth should be flat according to the cleff, they write a  $\flat$ .

In the same manner, if in a chord of the seventh of the tonic dominant, the dissonance, that is to say, the seventh, ought to be flat or natural, they write by the side of the seventh a  $\flat$  or a  $\natural$ . Many musicians, when a seventh from the simple dominant ought to be altered by a sharp or a natural, have likewise written by the side of the seventh a  $\sharp$  or a  $\natural$ ; but M. Rameau suppresses these characters. The reason shall be given below, when we speak of chords by supposition.

If there be a sharp on the cleff of *fa*, and if I should incline to mark the chord *sol fi re fa*, or the chord *la ut mi fa*, I would place before the seventh or the sixth a  $\sharp$  or a  $\flat$ .

In the same manner, if there be a flat on the cleff at *fi*, and if I should incline to mark the chord *ut mi sol fi*, I would place before the seventh a  $\sharp$  or a  $\flat$ , and so of the rest.

or dissonance, should likewise be found in the preceding chord.

## RULE III.

193. In every chord of the sub-dominant, at least one of its consonances must be found in the preceding chord. Thus, in the chord of the sub-dominant *fa la ut re*, it is necessary that *fa*, *la*, or *ut*, which are the consonances of the chord, should be found in the chord preceding. The dissonance *re* may either be found in it or not.

## RULE IV.

194. Every simple or tonic dominant ought to descend by a fifth. In the first case, that is to say, when the dominant is simple, the note which follows can only be a dominant; in the second it may be any one you choose; or, in other words, it may either be a tonic, a tonic dominant, a simple dominant, or a sub-dominant. It is necessary, however, that the conditions prescribed in the second rule should be observed, if it be a simple dominant.

This last restriction is necessary, as you will presently see. For let us assume the succession of the two chords *la ut* *mi sol*, *re fa la ut*, (see Exam. XIX.) this succession is by no means legitimate, though in it the first dominant descends by a fifth; because the *ut* which forms the dissonance in the second chord, and which belongs to a simple dominant, is not in the preceding chord. But the succession will be admissible, if, without meddling with the second chord, one should take away the sharp carried by the *ut* in the first; or if, without meddling with the first chord, one should render *ut* or *fa* sharp in the second (*uu*); or in short, if one should simply render the *re* of the second chord a tonic dominant, in causing it to carry *fa* instead of *fa* natural (119. & 122.).

It is likewise by the same rule that we ought to reject the succession of the two following chords,  
*re fa la ut*, *sol si re fa*;  
(see Exam. XX.).

## RULE V.

195. Every sub-dominant ought to rise by a fifth; and the note which follows it may, at your pleasure, be either a tonic, a tonic dominant, or a sub-dominant.

## REMARK.

<sup>104</sup> Of the five fundamental rules which have now been substituted. given, instead of the three first, one may substitute the three following, which are nothing but conse-

(uu) In this chord it is necessary that the *ut* and *fa* should be sharp at the same time; for the chord *re fa la ut*, in which *ut* would be sharp without the *fa*, is excluded by art. 179.

(xx) When the bass rises or descends from one tonic to another by the interval of a third, the mode is commonly changed; that is to say, from a major it becomes a minor. For instance, if I ascend from the tonic *ut* to the tonic *mi*, the major mode of *ut*, *ut mi sol ut*, will be changed into the minor mode of *mi*, *mi sol si mi*. For what remains, we must never ascend from one tonic to another, when there is no found common to both their modes; for example, you cannot rise to the mode of *ut*, *ut mi sol ut*, from the minor mode of *mi*, *mi sol si mi* (91.).

(vy) By this we may see, that all the intervals, viz. the third, the fifth, and second, may be admitted in the fundamental bass, except that of a second in descending. For what remains, it is very proper to remark, that the rules immediately given for the fundamental bass are not without exception, as approved compositions in music will certainly discover; but these exceptions being in reality licences, and for the most part in opposition to the great principle of connection, which prescribes that there should be at least one note in common between a preceding and a subsequent chord, it does not seem necessary to entertain inquiries with a minute detail of these licences in an elementary work, where the first and most essential rules of the art alone ought to be expected.

quences from them, and which you may pass unnoticed if you think it proper.

## RULE I.

If a note of the fundamental bass be a tonic, and rise by a fifth or a third to another note, that second note may be either a tonic, (34. & 91.) see Examples XXI. and XXII. (xx); a tonic dominant, (124.) see XXIII. and XXIV.; or a sub dominant, (124.) see XXV. and XXVI.; or, to express the rule more simply, that second note may be any one you please, except a simple dominant.

## RULE II.

If a note of the fundamental bass be a tonic, and descend by a fifth or a third upon another note, this second note may be either a tonic, (34. & 91.) see Exam. XXVII. and XXVIII.; or a tonic dominant, or a simple dominant, yet in such a manner that the rule of art. 192. may be observed, (124.) see XXIX. XXX. XXXI. XXXII.; or a sub-dominant (124.), see XXXIII. and XXXIV.

The procedure of the bass *ut mi sol ut*, *fa la ut mi*, from the tonic *ut* to the dominant *fa* (Ex. XXXV.), is excluded by art. 192.

## RULE III.

If a note in the fundamental bass be a tonic, and rise by a second to another note, that note ought to be a tonic dominant, or a simple dominant (101. & 102.). See XXXVI. and XXXVII. (vy).

We must here advertise our readers, that the examples XXXVIII. XXXIX. XL. XLI. belong to the fourth rule above, art. 194.; and the examples XLII. XLIII. XLIV. to the fifth rule above, art. 195. See the articles 34, 35, 121, 123, 124.

## REMARK I.

<sup>105</sup> 196. The transition from a tonic dominant to a Perfect and tonic is called an *absolute repose*, or a *perfect cadence* (perfect cadences, (73); and the transition from a sub-dominant to a what, and tonic is called an *imperfect* or *irregular cadence* (73); how the cadences are formed at the distance of four bars played. one from another, whilst the tonic then falls within the first time of the bar. See XLV. and XLVI.

## REMARK II.

<sup>106</sup> 197. We must avoid as much as we can, syncopation in the fundamental bass; that, within the first time only of which a bar is constituted, the ear may be entertained with a harmony different from that which it had before perceived in the last time of the preceding bar. by li-  
bar. cence.

Principles of Composition. Nevertheless, syncopation may be sometimes admitted in the fundamental bass, but it is by a licence (22).

CHAP. VII. *Of the Rules which ought to be observed in the Treble with relation to the Fundamental Bass.*

198. THE treble is nothing else but a modulation above the fundamental bass, and whose notes are found in the chords of that bass which corresponds with it, (189.) Thus in Ex. XVIII. the scale *ut re mi fa sol la si ut*, is a treble with respect to the fundamental bass *ut sol ut fa ut re sol ut*.

199. We are just about to give the rules for the treble; but first we think it necessary to make the two following remarks.

1. It is obvious, that many notes of the treble may answer to one and the same note in the fundamental bass, when these notes belong to the chord of the same note in the fundamental bass. For example, this modulation *ut mi sol mi ut*, may have for its fundamental bass the note *ut* alone, because the chord of that note comprehends the sounds *ut, mi, sol*, which are found in the treble.

2. In like manner, a single note in the treble may, for the same reason, answer to several notes in the bass. For instance, *sol* alone may answer to these three notes in the bass, *ut sol ut (AAA)*.

(22) There are notes which may be found several times in the fundamental bass in succession with a different harmony. For instance, the tonic *ut*, after having carried the chord *ut mi sol ut*, may be followed by another *ut* which carries the chord of the seventh, provided that this chord be the chord of the tonic dominant *ut mi sol si*. See LXXII. In the same manner, the tonic *ut* may be followed by the same tonic *ut*, which may be rendered a *sub-dominant*, by causing it to carry the chord *ut mi sol la*. See LXXIII.

A dominant, whether tonic or simple, sometimes descends or rises upon one another by the interval of a tritone or false fifth. For example, the dominant *fa*, carrying the chord *fa la ut mi*, may be followed by another dominant *si*, carrying the chord *si re fa la*. This is a licence in which the musician indulges himself, that he may not be obliged to depart from the scale in which he is; for instance, from the scale of *ut* to which *fa* and *si* belong. If one should descend from *fa* to *si*, by the interval of a just fifth, he would then depart from that scale, because *si* is no part of it.

(AAA) There are often in the treble several notes which may, if we choose, carry no chord, and be regarded merely as notes of passage, serving only to connect between themselves the notes that do carry chords, and to form a more agreeable modulation. These notes of passage are commonly quavers. See Exam. XLVII. in which this modulation *ut re mi fa sol*, may be regarded as equivalent to this other, *ut mi sol*, as *re* and *fa* are no more than notes of passage. So that the bass of this modulation may be simply *ut sol*.

When the notes are of equal duration, and arranged in a diatonic order, the notes which occupy the perfect part of each time, or those which are accented, ought each of them to carry chords. Those which occupy the imperfect part, or which are unaccented, are no more than mere notes of passage. Sometimes, however, the note which occupies the imperfect part may be made to carry harmony; but the value of this note is then commonly increased by a point which is placed after it, which proportionably diminishes the continuance of the note that occupies the perfect time, and makes it pass more swiftly.

When the notes do not move diatonically, they ought generally all of them to enter into the chord which is placed in the lower part correspondent with these notes.

(BBB) There is, however, one case in which the seventh of a simple dominant may be found in a modulation without being prepared. It is when, having already employed that dominant in the fundamental bass, its seventh is afterwards heard in the modulation, as long as this dominant may be retained. For instance, let us imagine this modulation,

<i>ut</i>		<i>re</i>	<i>ut</i>	<i>si</i>	<i>ut</i>		<i>re</i> ;
		7	7	7	7		
		<i>re</i>	<i>sol</i>	<i>ut</i>	<i>sol</i>		

and this fundamental bass,

(see Example LI.); the *re* of the fundamental bass answers to the two notes *re ut* of the treble. The dissonance *ut* has no need of preparation, because the note *re* of the fundamental bass having already been employed for the *re* which precedes *ut*, the dissonance *ut* is afterwards presented, below which the chord *re* may be preserved, or *re fa la ut*.

RULE I. for the TREBLE.

200. If the note which forms the seventh in a chord of the simple dominant is found in the treble, the note which precedes it must be the very same. This is what we call a *disord prepared* (122). For instance, let us suppose that the note of the fundamental bass shall be *re*, bearing the chord of the simple dominant *re fa la ut*; and that this *ut*, which (art. 18. & 118.) is the dissonance, should be found in the treble; it is necessary that the note which goes before it in the treble should likewise be an *ut*.

201. And it is requisite to observe, that, according to the rules which we have given for the fundamental bass, *ut* will always be found in the chord of that note in the fundamental bass which precedes the simple dominant *re*. See XLVIII. XLIX. L. In the first example the dissonance is *ut*, in the second *sol*, and in the third *mi*; and these notes are already in the preceding chord (BBB).

RULE II.

202. If a note of the fundamental bass be a tonic dominant, or a simple dominant, and if the dissonance be found in the treble, this dissonance in the same treble ought to descend diatonically. But if the note of the bass be a sub-dominant, it ought to rise diatonically. This dissonance which rises or descends diatonically, is what we have called a *dissonance saved* or *resolved* (129, 130). See LII. LIII. LIV.

203. One

Principles of Composition.

Principles  
of Compo-  
sition.

203. One may likewise observe here, that, according to the rules for the fundamental basfs which we have given, the note upon which the difsonance ought to defend or rise will always be found in the fublequent chord (ccc).

CHAP. VIII. *Of the Continued Basfs, and its Rules.*

\* See Conti-  
nued basfs.  
209  
Thorough-  
basfs, what.

204. A CONTINUED\* or thorough basfs, is nothing elfe but a fundamental basfs whose chords are inverted. We invert a chord when we change the order of the notes which compofe it. For example, if inftead of the chord *fol fi re fa*, I fhould fay *fi re fa fol*, or *re fa fol fi*, &c. the chord is inverted. Let us fee then, in the firft place, all the poffible ways in which a chord may be inverted.

210  
Chords in-  
verted,  
how.

*The ways in which a PERFECT CHORD may be INVERTED.*

205. The perfect chord *ut mi fol ut* may be inverted in two different ways.

1. *Mi fol ut mi*, which we call a chord of the *fixth*, compofed of a third, a fixth, and an octave and in this cafe the note *mi* is marked with a 6. (See LVI.)

2. *Sol ut mi fol*, which we call a chord of the *fixth and fourth*, compofed of a fourth, a fixth, and an octave; and it is marked with a 3. (See LVII.)

The perfect minor chord is inverted in the fame manner.

*The ways in which the CHORD of the SEVENTH may be INVERTED.*

206. In the chord of the tonic dominant, as *fol fi re fa*, the third major *fi* above the fundamental note *fol* is called a *fenfible note* (77.); and the inverted chord *fi re fa fol*, compofed of a third, a falfe fifth, and fixth, is called the *chord of the falfe fifth*, and is marked with an 8 or a 5 (fee LVIII. and LIX.)

The chord *re fa fol fi*, compofed of a third, a fourth,

and a fixth, is called the *chord of the fenfible fixth*, and marked with a 6 or a 6. In this chord thus figured, the third is minor, and the fixth major, as it is eafy to be perceived. (See LX.)

The chord *fa fol fi re*, compofed of a fecond, a tritone, and a fixth, is called the *chord of the tritone*, and is marked thus 4+, thus x4, or thus 4. (See LXI.)

207. In the chord of the fimple dominant *re fa la ut*, we find,

1. *Fa la ut re*, a chord of the great fixth, which is compofed of a third, a fifth, and a fixth, and which is figured with a 3. See LXIII. (ddd).

2. *La ut re fa*, a chord of the leffer fixth, which is figured with a 6. See LXIV. (eee).

3. *Ut re fa la*, a chord of the fecond, compofed of a fecond, a fourth, and a fixth, and which is marked with a 2. See LXII. (fff).

*The ways in which the CHORD of the sub-DOMINANT may be inverted.*

208. The chord of the sub-dominant, as *fa la ut re*, may be inverted in three different manners; but the method of inverting it which is moft in practice is the chord of the leffer fixth *la ut re fa*, which is marked with a 6, and the chord of the feventh *re fa la ut*. See LXIV.

RULES for the CONTINUED BASS.

200. The continued basfs is a fundamental basfs, whose chords are only inverted in order to render it more in the tafte of finging, and fuitable to the voice. See LXV. in which the fundamental basfs which in itfelf is monotonic and little futed for finging, *ut fol ut fol ut fol ut*, produces, by inverting its chords, this continued basfs highly proper to be lung, *ut fi ut re mi fa mi*, &c. (ggg.)

The continued basfs then is properly nothing elfe but

(ccc) When the treble fyncopefs in defcending diatonically, it is common enough to make the fecond part of the fyncope carry a difcord, and the firft a concord. See *Example LV.* where the firft part of the fyncopated note *fol* is in concord with the notes *ut mi fol ut*, which anfwer to it in the fundamental basfs, and where the fecond part is a difsonance in the fubfequent chord *la ut mi fol*. In the fame manner, the firft part of the fyncopated note *fa* is in concord with the notes *re fa la ut*, which anfwer to it; and the fecond part is a difsonance in the fubfequent chord *fol fi re fa*, which anfwer to it, &c.

(ddd) We are obliged to mark likewise, in the continued basfs, the chord of the sub-dominant with a 4, which in the fundamental basfs is figured with a 6 alone; and this to diftinguifh it from the chords of the fixth and of the leffer fixth. (See *Examples LVI. and LXIV.*) For what remains, the chord of the great fixth in the fundamental basfs carries always the fixth major, whereas in the continued basfs it may carry the fixth minor. For inftance, the chord of the feventh *ut mi fol fi*, gives the chord of the great fixth *mi fol fi ut*, thus improperly called, fince the fixth from *mi* to *ut* is minor.

(eee) M. Rameau has juftly obferved, that we ought rather to figure this leffer fixth with a 1, to diftinguifh it from the fenfible fixth which arifes from the chord of the tonic dominant, and from the fixth which arifes from the perfect chord. In the mean time he figures in his works with a 6 alone, the leffer fixths which do not arife from the tonic dominant; that is to fay, he figures them as thofe which arife from the perfect chord; and we have followed him in that, though we thought with him, that it would be better to mark this chord by a particular figure.

(fff) The chord of the feventh *fi re fa la* gives, when inverted, the chord *fa la fi re*, compofed of a third, a tritone, and a fixth. This chord is commonly marked with a 6, as if the tritone were a juft fourth. It is his bufinefs who performs the accompaniment, to know whether the fourth above *fa* be a tritone or a fourth redundant. One may, as to what remains, figure this chord thus 4+.

(ggg) The continued basfs is proportionally better adapted to finging, as the founds which form it more fcrupuloufly obferve the diatonic order, becaufe this order is the moft agreeable of all. We muft therefore endeavour to preferve it as much as poffible. It is for this reafon that the continued basfs in *Example LXV.* is much more in the tafte of finging, and more agreeable, than the fundamental basfs which anfwers to it.

Principles  
of Compo-  
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Principles  
of Compo-  
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but a treble with respect to the fundamental bass. Its rules immediately follow; which are properly no other than those already given for the treble.

## RULE I.

210. Every note which carries the chord of the false fifth, and which of consequence must be what we have called a *sensible note*, ought (77) to rise diatonically upon the note which follows it. Thus in example LXV. the note *fa*, carrying the chord of the false fifth marked with an 8, rises diatonically upon *ut* (HHH).

## RULE II.

211. Every note carrying the chord of the tritone should descend diatonically upon the subsequent note. Thus in the same example LXV. *fa*, which carries the chord of the tritone figured with a 4+, descends diatonically upon *mi*. (Art. 202.)

## RULE III.

212. The chord of the second is commonly put in

(HHH) The continued bass being a kind of treble with relation to the fundamental bass, it ought to observe the same rules with respect to that bass as the treble. Thus a note, for instance *re*, carrying a chord of the seventh *re fa la ut*, to which the chord of the sub-dominant *fa la ut re* corresponds in the fundamental bass, ought to rise diatonically upon *mi*, (art. 129, n° 2. and art. 202.)

(111) When there is a *repose* in the treble, the note of the continued bass ought to be the same with that of the fundamental bass, (see example LXVII.) In the closes which are found in the treble at *fa* and *ut* (bars third and fourth), the notes in the fundamental and continued bass are the same, viz. *sol* for the first cadence, and *ut* for the second. This rule ought above all to be observed in final cadences which terminate a piece or a modulation.

It is necessary, as much as possible, to prevent coincidences of the same notes in the treble and continued bass, unless the motion of the continued bass should be contrary to that of the treble. For example, in the second note of the second bar in example LXVII. *mi* is found at the same time in the continued bass and in the treble: but the treble descends from *fa* to *mi*, whilst the bass rises from *re* to *mi*.

Two octaves, or two fifths, in succession, must likewise be shunned. For instance, in the treble sounds *sol mi*, the bass must be prevented from sounding *sol mi, ut la, or re fa*; because in the first case there are two octaves in succession, *sol* against *sol*, and *mi* against *mi*; and because in the second case there are two fifths in succession, *ut* against *sol*, and *la* against *mi*, or *re* against *sol*, and *fa* against *mi*. This rule, as well as the preceding, is founded upon this principle, that the continued bass ought not to be a copy of the treble, but to form a different melody.

Every time that several notes of the continued bass answer to one note alone of the fundamental, the composer satisfies himself with figuring the first of them. Nay, he does not even figure it if it be a tonic; and he draws above the others a line, continued from the note upon which the chord is formed. See example LXVIII. where the fundamental bass *ut* gives the continued bass *ut mi sol mi*: the two *mi*'s ought in this bass to carry the chord 6, and *sol* the chord  $\frac{6}{4}$ ; but as these chords are comprehended in the perfect chord *ut mi sol ut*, which is the first of the continued bass, we place nothing above *ut*, only we draw a line over *ut mi sol mi*.

In like manner, in the second bar of the same example, the notes *fa* and *re* of the continued bass, rising from the note *sol* alone of the fundamental bass which carries the chord *sol fa re fa*; we think it sufficient to figure *fa* with the number of the tritone 4x, and to draw a line above *fa* and *re*.

It should be remarked, that this *fa* ought naturally to descend to *mi*: but this note is considered as subsisting so long as the chord subsists; and when the chord changes, we ought necessarily to find the *mi*, as may be seen by that example.

In general, whilst the same chord subsists in passing through different notes, the chord is reckoned the same as if the first note of the chord had subsisted; in such a manner, that, if the first note of the chord is, for instance, the sensible note, we ought to find the tonic when the chord changes. See example LXIX. or this continued bass, *ut fa sol fa re ut*, is reckoned the same with this *ut fa ut*. (Example LXX.)

If a single note of the continued bass answers to several notes of the fundamental bass, it is figured with the different chords which agree to it. For example, the note *sol* in a continued bass may answer to this fundamental bass *ut sol ut*, (see example LXXI.); in this case, we may regard the note *sol* as divided into three parts, of which the first carries the chord  $\frac{6}{4}$ , the second the chord 7, and the third the chord  $\frac{6}{5}$ .

We shall repeat here, with respect to the rules of the continued bass, what we have formerly said concerning the rules of the fundamental bass in the note upon the third rule, art. 193. The rules of the continued bass have exceptions, which practice and the perusal of good authors will teach. There are likewise several other rules which might require a considerable detail, and which will be found in the *Treatise of Harmony* by M. Rameau, and elsewhere. These rules, which are proper for a complete dissertation, did not appear to me indispensably necessary in an elementary essay upon music, such as the present. The books which we have quoted at the end of our preliminary discourse will more particularly instruct the reader concerning this practical detail.

(LLL) One may sometimes, but very rarely, cause several tonics in succession to follow one another in ascend-

ing, because these notes are dissonances which ought to be prepared and resolved (200, 202.) See the example LXVI. where the second *ut*, which is synco-pated, and which descends afterwards upon *fa*, carries the chord of the second (111).

## CHAP. IX. Of some Licences assumed in the Fundamental Bass.

## § 1. Of Broken and Interrupted Cadences.

213. The broken cadence is executed by means of a dominant which rises diatonically upon another, or upon a tonic by a licence. See, in the example LXXIV. *sol la*, (132, and 134).

214. The interrupted cadence is formed by a dominant which descends by a third upon another (136). See, in the example LXXV. *sol mi* (LLL).

These cadences ought not to be permitted but rarely

Principles  
of Compo-  
sition.Broken ca-  
dence how  
executed.Interrupted  
cadence  
how form-  
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Principles of Composition ly and with precaution.

213 Chord by supposition.

See Supposition.

214 These different chords what, and how figured.

§ 2. Of SUPPOSITION.

215. When a dominant is preceded by a tonic in the fundamental bass, we add sometimes, in the continued bass to the chord of that dominant, a new note which is a third or a fifth below; and the chord which results from it in this continued bass is called a chord by supposition.

For example, let us suppose that in the fundamental bass we have a dominant *sol* carrying the chord of the seventh *sol si re fa*; let us add to this chord the note *ut*, which is a fifth below this dominant, and we shall have the total chord *ut sol si re fa*, or *ut re fa sol si*, which is called a chord by supposition.

Of the different kinds of chords by supposition.

216. It is easy to perceive, that chords by supposition are of different kinds. For instance, the chord of the tonic *sol si re fa* gives,

1. By adding the fifth *ut*, the chord *ut sol si re fa*, called a chord of the seventh redundant, and composed of a fifth, seventh, ninth, and eleventh. It is figured with a ♯7; see LXXVI. (NNN). This chord is not practised but upon the tonic. They sometimes leave

ing or descending diatonically, as *ut mi sol ut, re fa la re, si re fa si*; but, besides that this succession is harsh, it is necessary, in order to render it practicable, that the fifth below the first tonic should be found in the chord of the tonic following, as here *fa*, a fifth below the first tonic *ut*, is found in the chord *re fa la re*, and in the chord *si re fa si* (37 and note c.)

(MMM) Though supposition be a kind of licence, yet it is in some measure founded on the experiment related in the note (F), where you may see that every principal or fundamental sound causes its twelfth and seventeenth major in descending to vibrate, whilst the twelfth and the seventeenth major ascending resound: which seems to authorize us in certain cases to join with the fundamental harmony this twelfth and seventeenth in descending, or which is the same thing, the fifth or the third beneath the fundamental sound.

Even without having recourse to this experiment, we may remark, that the note added beneath the fundamental sound, causes that very fundamental sound to be heard. For instance, *ut* added beneath *sol*, causes *sol* to resound. Thus *sol* is found in some measure to be implied in *ut*.

If the third added beneath the fundamental sound be minor, for example, if to the chord *sol si re fa*, we add the third *mi*, the supposition is then no longer founded on the experiment, which only gives the seventeenth major, or, what is the same thing, the third major beneath the fundamental sound. In this case the addition of the third minor must be considered as an extension of the rule, which in reality has no foundation in the chords emitted by a sonorous body, but is authorized by the sanction of the ear and by practical experiment.

(NNN) Many musicians figure this chord with a ♯7; M. Rameau suppresses this 2, and merely marks it to be the seventh redundant by a 7♯ or ♯7. But it may be said, how shall we distinguish this chord from the seventh major, which, as it would seem, ought to be marked with a 7♯? M. Rameau answers, that there is no danger of mistake, because in the seventh major, as the seventh ought to be prepared, it is found in the preceding chord; and thus the sharp subsisting already in the preceding chord, it would be useless to repeat it.

Thus *re sol*, according to M. Rameau, would indicate *re fa<sup>7</sup> la ut, sol si re fa<sup>7</sup>*. If we would change *fa<sup>7</sup>*

of the second chord into *fa*, it would then be necessary to write *re sol*. In notes such as *ut*, whose natural seventh is major, the figure 7 preceded or followed by a sharp will sufficiently serve to distinguish the chord of the seventh redundant *ut sol si re fa*, from the simple chord of the seventh *ut mi sol si*, which is marked with a 7 alone. All this appears just and well-founded.

(OOO) Supposition introduces into a chord dissonances which were not in it before. For instance, if to the chord *mi sol si re*, we should add the note of supposition *ut* descending by a third, it is plain that, besides the dissonance between *mi* and *re* which was in the original chord, we have two new dissonances, *ut si* and *ut re*; that is to say, the seventh and the ninth. These dissonances, like the others, ought to be prepared and resolved. They are prepared by being synopated, and resolved by descending diatonically upon one of the consonances of the subsequent chord. The sensible note alone can be resolved in ascending; but it is even necessary that this sensible note should be in the chord of the tonic dominant. As to the dissonances which are found in the primitive chord, they should always follow the common rules. (See art. 202.)

(PPP) Several musicians call this last chord the chord of the ninth; and that which, with M. Rameau, have

out the sensible note, for reasons which we shall give in the note *ooo*, upon the art. 219; it is then reduced to *ut fa sol re*, and marked with 4 or 1.

2. By adding the third *mi*, we shall have the chord *mi sol si re fa*, called a chord of the ninth, and composed of a third, fifth, seventh, and ninth. It is figured with a 9. This third may be added to every third of the dominant. See LXXVII. (OOO).

3. If to a chord of the simple dominant, as *re fa la ut*, we should add the fifth *sol*, we would have the chord *sol re fa la ut*, called a chord of the eleventh, and which is figured with a 2 or 3. (See LXXVIII.)

OBSERVE.

217. WHEN the dominant is not a tonic dominant, they often take away some notes from the chord. For example, let us suppose that there is in the fundamental bass this simple dominant *mi*, carrying the chord *mi sol si re*: if there should be added the third *ut* beneath, we shall have this chord of the continued bass *ut mi sol si re*, but they suppress the seventh *si*, for reasons which shall be explained in the note *ooo* upon art. 219. In this state the chord is simply composed of a third, fifth, and ninth, and is marked with a 9. See LXXIX. (PPP).

215 Occasions when re- trench- ments of chords are proper.

218.

Principles of Composition.

218. What is more, in the chord of the simple dominant, as *re fa la ut*, when the fifth *sol* is added they frequently obliterate the sounds *fa* and *la*, that too great a number of dissonances may be avoided, which reduces the chord to *sol ut re*. This last is composed only of the fourth and the fifth. It is called a *chord of the fourth*, and it is figured with a 4. (See LXXX.)

216 Chord of the fifth redundant what, and how figured.

219. Sometimes they only remove the note *la*, and then the chord ought to be figured with  $\dot{2}$  or  $\dot{2}$  (qqq).  
220. Finally, in the minor mode, for example, in that of *la*, where the chord of the tonic dominant (109), is *mi sol $\frac{b}{b}$  si re*; if we add to this chord the third *ut* below, we shall have *ut mi sol $\frac{b}{b}$  si re*, called the *chord of the fifth redundant*, and composed of a third, a fifth redundant, a seventh, and a ninth. It is figured with a  $\frac{3}{5}$ , or a +5. See LXXXI. (RRR).

217 Chord of the flat seventh what, and how figured.

### § 3. Of the CHORD of the DIMINISHED SEVENTH.

221. In the minor mode, for instance, in that of *la*, *mi* a fifth from *la* is the tonic dominant (109), and carries the chord *mi sol $\frac{b}{b}$  si re*, in which *sol* is the sensible note. For this chord they sometimes substitute that other *sol $\frac{b}{b}$  si re fa* (116), all composed of minor thirds; and which has for its fundamental sound the sensible note *sol $\frac{b}{b}$* . This chord is called a *chord of the flat, or diminished seventh*, and is figured with a  $\frac{7}{b}$  in the fundamental bass, (see LXXXII.); but it is always considered as representing the chord of the tonic dominant.

218 Chords produced in the continued bass by this what, and how figured.

222. This chord in the fundamental bass produces in the continued bass the following chords:

1. The chord *si re fa sol $\frac{b}{b}$* , composed of a third, false

have simply called a *chord of the ninth*, they term a *chord of the ninth and seventh*. This last chord they mark with a  $\frac{9}{b}$ ; but the denomination and figure used by M. Rameau are more simple, and can lead to no error; because the chord of the ninth always includes the seventh, except in the cases of which we have already spoken.

(qqq) They often remove some dissonances from chords of supposition, either to soften the harshness of the chord, or to remove discords which can neither be prepared nor resolved. For instance, let us suppose, that in the continued bass the note *ut* is preceded by the sensible note *si*, carrying the chord of the false fifth, and that we should choose to form upon this note *ut* the chord *ut mi sol $\frac{b}{b}$  si re*, we must obliterate the seventh *si*, because in retaining it we should destroy the effect of the sensible note *si*, which ought to rise to *ut*.

In the same manner, if to the harmony of a tonic dominant *sol si re fa*, one should add the note by supposition *ut*, it is usual to retrench from this chord the sensible note *si*; because, as the *re* ought to descend diatonically to *ut*, and the *si* to rise to it, the effect of the one would destroy that of the other. This above all takes place in the *suspense*, concerning which we shall presently treat.

(RRR) *Supposition* produces what we call *suspense*; and which is almost the same thing. *Suspension* consists in retaining as many as possible of the sounds in a preceding chord, that they may be heard in the chord which

succeeds. For instance, if this fundamental bass be given *ut sol ut*, and this continued bass above it *ut ut ut*,

it is a supposition; but if we have this fundamental bass *ut sol $\frac{7}{b}$  ut*, and this continued bass above it *ut sol $\frac{7}{b}$  ut*, it is a *suspense*; because the perfect chord of *ut*, which we naturally expect after *sol* in the continued bass, is

*suspended and retarded* by the chord *ut*, which is formed by retaining the sounds *sol si re fa* of the preceding

chord to join them to the note *ut* in this manner, *ut sol si re fa*; but this chord *ut* does nothing in this case but *suspend* for a moment the perfect chord *ut mi sol ut*, which ought to follow it.

(sss) The chord of the diminished seventh, such as *sol $\frac{b}{b}$  si re fa*, and the three derived from it, are termed *chords of substitution*. They are in general *harsh*, and proper for imitating melancholy objects.

(TTT) As the chord of the diminished seventh *sol $\frac{b}{b}$  si re fa*, and the chord of the tonic dominant *mi sol $\frac{b}{b}$  si re*, only differ one from the other by the notes *mi* and *fa*; one may form a diatonic modulation of these two notes, and then the fundamental bass does nothing but pass from the tonic dominant to the sensible note, and from that note to the tonic dominant, till it arrives at the tonic. (See XCII.)

For the same reason, as the chord of the diminished seventh *sol $\frac{b}{b}$  si re fa*, and the chord *si re fa la*, which

fifth, and sixth major. They call it the *chord of the sixth sensible and false fifth*; and it is figured thus  $\frac{6}{b}$ , or + $\frac{6}{b}$ . (See LXXXIII).

2. The chord *re fa sol $\frac{b}{b}$  si*, composed of a third, a triton, and a sixth, they call it the *chord of the triton and third minor*; and they mark it thus  $\frac{4}{b}$ . (See LXXXIV).

3. The chord *fa sol $\frac{b}{b}$  si re*, composed of a second redundant, a tritone, and a sixth. They call it the *chord of the second redundant*, and they figure it thus  $\frac{2}{b}$ , or +2. See LXXXV. (sss).

223. Besides, since the chord *sol $\frac{b}{b}$  si re fa*, represents the chord *mi sol $\frac{b}{b}$  si re*, it follows, that if we operate by supposition upon the first of these chords, it must be performed as one would perform it upon *mi sol $\frac{b}{b}$  si re*; that is to say, that it will be necessary to add to the chord *sol $\frac{b}{b}$  si re fa*, the notes *ut* or *la*, which are the third or fifth below *mi*, and which will produce,

1. By adding *ut*, the chord *ut sol $\frac{b}{b}$  si re fa*, composed of a fifth redundant, a seventh, a ninth, and eleventh, which is the octave of the fourth. It is called a *chord of the fifth redundant and fourth*, and thus marked  $\frac{5}{4}$ , or  $\frac{5}{4}$ . (See LXXXVI.)

2. By adding *la*, we shall have the chord *la sol $\frac{b}{b}$  si re fa*, composed of a seventh redundant, a ninth, an eleventh, and a thirteenth minor, which is the octave of the sixth minor. It is called the *chord of the seventh redundant and sixth minor*, and marked  $\frac{7}{6}$ , or  $\frac{7}{6}$ . (See LXXXVII.) It is of all chords the most harsh, and the most rarely practised (TTT).

[ g 2 ]

In

Principles of Composition.

219 Alterations by supposition, chords which they produce what, and how figured.

Principles of Composition.

In the *Treatise of Harmony* by M. Rameau, and elsewhere, may be seen a much longer detail of the chords by supposition: But here we delineate the elements alone.

the chord *ut mi sol ut*.

Principles of Composition.

CHAP. XI. *Containing the Method of finding the Fundamental Bafs when the Continued Bafs is figured.*

220 Licence 1ft.

CHAP. X. *Of some Licences used in the Treble and Continued Bafs.*

224. Sometimes in a treble, the difsonance which ought to have been resolved by descending diatonically upon the succeeding note, instead of descending, on the contrary rises diatonically: but in that case, the note upon which it ought to have descended must be found in some of the other parts. This licence ought to be rarely practised.

In like manner, in a continued bafs, the difsonance in a chord of the sub-dominant inverted, as *la* in the chord *la ut mi sol*, inverted from *ut mi sol la*, may sometimes descend diatonically instead of rising as it ought to do, art. 129, n<sup>o</sup> 2.; but in that case the note ought to be repeated in another part, that the difsonance may be there resolved in ascending.

221 Licence 2d.

225. Sometimes likewise, to render a continued bafs more agreeable by causing it to proceed diatonically, they place between two sounds of that bafs a note which belongs to the chord of neither. See example XCIV, in which the fundamental bafs *sol ut* produces the continued bafs *sol la si sol ut*, where *la* is added on account of the diatonic modulation. This *la* has a line drawn above it to shew its resolution by passing under the chord *sol si re fa*.

In the same manner, (see XCV), this fundamental bafs *ut fa* may produce the continued bafs *ut re mi ut fa*, where the note *re* which is added passes under

226. To exercise yourself with greater ease in finding the fundamental bafs, and to render it more familiar to you, it is necessary to observe how eminent masters, and above all how M. Rameau, has put the rules in practice. Now, as they never place any thing but the continued bafs in their works, it becomes then necessary to know how to find the fundamental bafs when the continued bafs is figured. This problem may be easily solved by the following rules.

222 How to find the fundamental bafs when the continued is figured.

227. 1. Every note which has no figure in the continued bafs, ought to be the same, and without a figure in the fundamental bafs; it either is a tonic, or reckoned such, (vuu).

2. Every note which in the continued bafs carries a 6, ought in the fundamental bafs to give its third below not figured <sup>6</sup>, or its fifth below marked with a 7. \* See Figured.

3. Every note carrying <sup>6</sup>/<sub>2</sub> gives in the fundamental bafs its fifth below not figured. (See LVII.)

4. Every note figured with a 7 or a <sup>7</sup>/<sub>4</sub>, is the same in both basses, and with the same figure (xxx).

5. Every note figured with a 2 gives in the fundamental bafs the diatonic note above figured with a 7. See LXII. (vyy).

6. Every note marked with a 4 gives in the fundamental bafs the diatonic note above, figured with a 7. (See LXI.)

7. Every

carries the fifth *si* of the tonic dominant *mi*, only differs by the sensible note *sol*<sup>6</sup>/<sub>2</sub>, and the tonic *la*; one may sometimes, while the treble modulates *sol*<sup>6</sup>/<sub>2</sub> *la* *sol*<sup>6</sup>/<sub>2</sub> *la*, ascend in the fundamental bafs, from the sensible note to the third above, provided one descend at last from thence to the tonic dominant, and from thence to the tonic; (see XCIII.) As to what remains, this and the preceding examples are licences.

(vuu) I say a tonic, or reckoned such, because it may perhaps be a dominant from which the difsonance has been removed. But in that case one may know that it is a real dominant by the note which precedes it. For instance, if the note *sol*, carrying a perfect chord, is preceded by *re* a simple dominant, carrying the chord *re fa la ut*, that note *sol* is not a real tonic; because, in order to this, it would have been necessary that *re* should have been a tonic dominant, and should have carried the chord *re fa la ut*; and that a simple dominant, as *re*, carrying the chord *re fa la ut*, should only naturally descend to a dominant, (art. 194.)

(xxx) Sometimes a note which carries a 7 in the continued bafs, gives in the fundamental bafs its third above, figured with a 6. For example, this continued bafs *la si ut* gives this fundamental bafs *ut sol ut*; but in this case it is necessary that the note figured with a 6 should rise by a fifth, as we see here *ut* rise to *sol*.

(vyy) A note figured with a 2, gives likewise sometimes in the fundamental bafs its fourth above, figured with a 6; but it is necessary in that case that the note figured with a 6, may even here rise to a fifth. (See note xxx).

These variations in the fundamental bafs, as well in the chord concerning which we now treat, as in the chord figured with a 7, and in two others which shall afterwards be mentioned (art. 228 and 229), are caused by a deficiency in the signs proper for the chord of the sub-dominant, and for the different arrangements by which it is inverted.

M. l'Abbe Rouffier, to redress this deficiency, had invented a new manner of figuring the continued bafs. His method is most simple for those who know the fundamental bafs. It consists in expressing each chord by only signifying the fundamental found with that letter of the scale by which it is denominated, to which is joined a 7 or <sup>7</sup>/<sub>4</sub>, or a 6, in order to mark all the discords. Thus the fundamental chord of the seventh *re fa la ut* is expressed by <sup>7</sup>/<sub>4</sub> D; and the same chord, when it is inverted from that of the sub-dominant *fa la ut re*, is characterized by <sup>7</sup>/<sub>4</sub> F; the chord of the second *ut re fa la*, inverted from the dominant *re fa la ut*, is likewise represented by <sup>6</sup>/<sub>2</sub> D; and the same chord *ut re fa la* inverted from that of the sub-dominant *fa la ut re* is signified by <sup>6</sup>/<sub>2</sub> F: the case is the same when the chords are differently inverted. By this means it would be impossible to mistake either with respect to the fundamental bafs of a chord, or with respect to the note which forms its difsonance, or with respect to the nature and species of that discord.

Principles of Composition.

Principles of Composition.

- 7. Every note figured with an 8 gives its third below figured with a 7. (See LVIII.)
- 8. Every note marked with a 6 gives the fifth below marked with a 7; (see LX.) and it is plain by art. 187, that in the chord of the seventh, of which we treat in these three last articles, the third ought to be major, and the seventh minor, this chord of the seventh being the chord of the tonic dominant. (See art. 102.)
- 9. Every note marked with a 9 gives its third above figured with a 7. (See LXXVII and LXXIX.)
- 10. Every note marked with a 2 gives the fifth above figured with a 7. (See LXXVIII.)
- 11. Every note marked with a  $\frac{5}{\flat}$ , or with a +5, gives the third above figured with a  $\frac{7}{\flat}$ . (See LXXXI.)
- 12. Every note marked with a  $\frac{7}{\sharp}$  gives a fifth above figured with a 7, or with a  $\frac{5}{\sharp}$ . (See LXXXVI.) It is the same case with the notes marked  $\frac{5}{\flat}$ ,  $\frac{4}{\flat}$ , or  $\frac{4}{\sharp}$ : which shows a retrenchment, either in the complete chord of the eleventh, or in that of the seventh redundant.
- 13. Every note marked with a 4 gives a fifth above figured with a 7, or a  $\frac{3}{\sharp}$ . (See LXXX.)
- 14. Every note marked with a  $\frac{3}{\sharp}$  gives the third minor below, figured with a  $\frac{7}{\sharp}$ . (See LXXXIII.)
- 15. Every note marked with a  $\frac{5}{\flat}$  gives the tritone above, figured with a  $\frac{7}{\flat}$ . (See LXXXIV.)
- 16. Every note marked with a +2 gives the second redundant above, figured with a  $\frac{7}{\sharp}$ . (See LXXXV.)
- 17. Every note marked with a  $\frac{5}{\sharp}$  gives the fifth redundant above, figured with a  $\frac{7}{\sharp}$ . (See LXXXVI.)
- 18. Every note marked with a  $\frac{7}{\flat}$  gives the seventh redundant above, figured with a  $\frac{7}{\flat}$ . See LXXXVII. (zzz).

REMARK.

228. We have omitted two cases cases, which may cause some uncertainty. The first is that where the note of the continued bass is figured with a 6. We now present the reason of the difficulty.

Suppose we should have the dominant *re* in the fundamental bass, the note which answers to it in the continued bass may be *la* carrying the figure 6, (see

LXIV.); that is to say, the chord *la ut re fa*: now if we should have the sub-dominant *fa* in the fundamental bass, this sub-dominant might produce in the continued bass the same note *la* figured with a 6. When therefore one finds in the continued bass a note marked with a 6, it appears at first uncertain whether we should place in the fundamental bass the fifth below marked with a 7, or the third below marked with a 6. 229. The second case is that in which the continued bass is figured with a  $\frac{5}{\flat}$ . For instance, if there

should be found *fa* in the continued bass, one may be ignorant whether he ought to infer in the fundamental bass *fa* marked with a 6, or *re* figured with a 7. 230. You may easily extricate yourself from this little difficulty, in leaving for an instant this uncertain note in suspense, and in examining what is the succeeding note of the fundamental bass; for if that note be in the present case a fifth above *fa*, that is to say, if it is *ut*, in this case, and in this alone, he may place *fa* in the fundamental bass. It is a consequence of this rule, that in the fundamental bass every sub-dominant ought to rise by a fifth (195).

CHAP. XII. What is meant by being in a Mode or Tone.

231. In the first part of this treatise (chap. vi.) we have explained, how by the means of the note *ut*, and of its two fifths *sol* and *fa*, one in ascending, which is called a tonic dominant, the other in descending, which is called a sub-dominant, the scale *ut re mi fa sol la si ut* may be found; the different sounds which form this scale compose what we call the major mode of *ut*, because the third *mi* above *ut* is major. If therefore we would have a modulation in the major mode of *ut*, no other sounds must enter into it than those which compose this scale; in such a manner that if, for instance, I should find *fa* in this modulation, this *fa* discovers to me that I am not in the mode of *ut*, or at least that, if I have been in it, I am no longer so.

232. In the same manner, if I form this scale in ascending *la si ut re mi fa sol la*, which is exactly similar to the scale *ut re mi fa sol la si ut* of the major mode of *ut*, this scale, in which the third from *la* to *ut* is major, shall be in the major mode of *la*; and if I incline to be in the minor mode of *la*, I have nothing

(zzz) We may only add, that here and in the preceding articles, we suppose, that the continued bass is figured in the manner of M. Rameau. For it is proper to observe, that there are not, perhaps, two musicians who characterize their chords with the same figures; which produces a great inconveniency to the person who plays the accompaniments, as may be seen in the article *Chiffre*, in Vol. III. of the *Encyclopedie*; an admirable article, of which M. Rousseau of Geneva is the author: but here we do not treat of accompaniments. For every reason, then, we should advise initiates to prefer the continued basses of M. Rameau to all the others, as by them they will most successfully study the fundamental bass.

It is even necessary to advertise the reader, and I have already done it (note EEE), that M. Rameau only marks the lesser sixth by a 6 without a line, when this lesser sixth does not result from the chord of the tonic dominant; in such a manner that the 6 renders it uncertain whether in the fundamental bass we ought to choose the third or the fifth below: but it will be easy to see whether the third or the fifth is signified by that figure. This may be distinguished, 1. In observing which of the two notes is excluded by the rules of the fundamental bass. 2. If the two notes may with equal propriety be placed in the fundamental bass, the preference must be determined by the tone or mode of the treble in that particular passage. In the following chapter we shall give rules for determining the mode.

There is a chord of which we have not spoken in this enumeration, and which is called the chord of the fifth redundant. This chord is composed of a note, of its third major, of its redundant fourth or tritone, and its redundant sixth, as *fa la si re* &c. It is marked with a 6 $\frac{5}{\flat}$ . It appears difficult to find a fundamental bass for this chord; nor is it indeed much in use amongst us. (See the note upon the art. 115.)

223 A difficulty in finding the fundamental bass.

229 Another.

225 Solution.

226 Method of determining the mode in which we are.

Principles of Composition. to do but to substitute for *ut* sharp *ut* natural; so that the major third *la ut* may become minor *la ut*; I shall have then

*la fi ut re mi fa* sol *la*, which is (85) the scale of the minor mode of *la* in ascending; and the scale of the minor mode of *la* in descending shall be (90)

*la sol fa mi ut re fi la*, in which the *sol* and *fa* are no longer sharp. For it is a singularity peculiar to the minor mode, that its scale is not the same in rising as in descending (89).

233. This is the reason why, when we wish to begin a piece in the major mode of *la*, we place three sharps at the cleff upon *fa*, *ut*, and *sol*; and on the contrary, in the minor mode of *la*, we place none, because the minor mode of *la*, in descending, has neither sharps nor flats.

234. As the scale contains twelve sounds, each distant from the other by the interval of a semitone, it is obvious that each of these sounds can produce both a major and a minor mode, which constitute 24 modes upon the whole. Of these we shall immediately give a table, which may be very useful to discover the mode in which we are.

A TABLE of the DIFFERENT MODES.

Major Modes.

Maj. Mode.

of <i>ut</i>	<i>ut re mi fa sol la fi ut.</i>
of <i>sol</i>	<i>sol la fi ut re mi fa</i> sol.
of <i>re</i>	<i>re mi fa</i> sol <i>la fi ut</i> re.
of <i>la</i>	<i>la fi ut</i> re <i>mi fa</i> sol <i>la</i> .
of <i>mi</i>	<i>mi fa</i> sol <i>la fi ut</i> re <i>mi</i> .
of <i>fi</i>	<i>fi ut</i> re <i>mi fa</i> sol <i>la</i> <i>fi</i> .
of <i>fa</i>	<i>fa</i> sol <i>la fi ut</i> re <i>mi fa</i> (AAAA).
of <i>ut</i>	} <i>re</i> <i>mi</i> <i>fa sol la</i> <i>fi ut re</i> .
or <i>re</i>	
of <i>sol</i>	} <i>la</i> <i>fi ut re</i> <i>mi</i> <i>fa sol la</i> .
or <i>la</i>	
of <i>re</i>	} <i>mi</i> <i>fa sol la</i> <i>fi ut re</i> <i>mi</i> .
or <i>mi</i>	
of <i>la</i>	} <i>fi ut re</i> <i>mi</i> <i>fa sol la</i> <i>fi</i> .
or <i>fi</i>	
of <i>mi</i>	} <i>fa sol la</i> <i>fi ut re</i> <i>mi</i> <i>fa</i> .
or <i>fa</i>	
of <i>fi</i>	} <i>ut re</i> <i>mi</i> <i>fa sol la</i> <i>fi ut</i> .
or <i>ut</i>	

(AAAA) The major mode of *fa*, of *ut* or *re*, and of *sol* or *la*, are not much practised. In the opera of *Pyramus* and *Thybe*, p. 267, there is a passage in the scene, of which one part is in the major mode of *fa*, and the other in the major mode of *ut*, and there are six sharps at the cleff.

When a piece begins upon *ut*, there ought to be seven sharps placed at the cleff: but it is more convenient only to place five flats, and to suppose the key *re*, which is almost the same thing with *ut*. It is for this reason that we substitute here the mode of *re* for that of *ut*.

It is still much more necessary to substitute the mode of *la* for that of *sol*; for the scale of the major mode of *sol* is *sol*, *la*, *fi*, *ut*, *re*, *mi*, *fa*, *sol*, *la*, *fi*, *ut*, *re*, *mi*, *fa*, *sol*, *la*, *fi*, *ut*; in which you may see that there are at the same time both a *sol* natural and a *sol*: it would then be necessary, even at the same time, that upon *sol* there should and should not be a sharp at the cleff; which is shocking and inconsistent. It is true that this inconvenience may be avoided by placing a sharp upon *sol* at the cleff, and by marking the note *sol* with a natural through the course of the music wherever it ought to be natural; but this would become troublesome, above all if there should be occasion to transpose. In the article 236, we shall give an account of transposition. One might likewise in this series, instead of *sol* natural, which is the note immediately before the last, substitute *fa*, that is to say, *fa* twice sharp; which, however, is not absolutely the same sound with *sol* natural, especially upon instruments whose scales are fixed, or whose intervals are invariable. But in that case two sharps may be placed at the cleff upon *fa*, which would produce another inconvenience. But by substituting *la* for *sol*, the trouble is eluded.

(BBBB) We have already seen, that in each mode the principal note is called a tonic; that the fifth above that note

Minor Modes.

Of *la*.

In descending. *la sol fa mi re ut fi la*.  
In rising. *la fi ut re mi fa* sol *la*.

Of *mi*.

In descending. *mi re ut fi la sol fa* *mi*.  
In rising. *mi fa* sol *la fi ut* re *mi*.

Of *fi*.

In descending. *fi la sol fa* *mi re ut* *fi*.  
In rising. *fi ut* re *mi fa* sol *la* *fi*.

Of *fa*.

In descending. *fa* *mi re ut* *fi la sol* *fa*.  
In rising. *fa* sol *la fi ut* re *mi* *fa*.

Of *ut*.

In descending. *ut* *fi la sol* *fa* *mi re* *ut*.  
In rising. *ut* re *mi fa* sol *la* *fi* *ut*.

Of *sol* or *la*.

In descending. *sol* *fa* *mi ut* *fi la* sol *la*.  
In rising. *la* *fi ut* re *mi* *fa* sol *la*.

Of *re* or *mi*.

In descending. *mi* re *ut* *fi* *la* sol *la* *fi* *ut*.  
In rising. *mi* *fa* sol *la* *fi ut* re *mi*.

Of *la* or *fi*.

In descending. *fi* *la* sol *la* *fi* *ut* re *mi* *fa*.  
In rising. *fi ut* re *mi* *fa* sol *la* *fi*.

Of *mi* or *fa*.

In descending. *fa* *mi* re *ut* *fi* *la* sol *la*.  
In rising. *fa* sol *la* *fi ut* re *mi* *fa*.

Of *ut*.

In descending. *ut* *fi* *la* sol *la* *fi* *ut*.  
In rising. *ut* re *mi* *fa* sol *la* *fi ut*.

Of *sol*.

In descending. *sol* *fa* *mi* re *ut* *fi* *la* sol *la*.  
In rising. *sol* *la* *fi ut* re *mi* *fa* sol *la*.

Of *re*.

In descending. *re ut* *fi* *la* sol *la* *fi* *ut*.  
In rising. *re mi* *fa* sol *la* *fi ut* re (BBBB).

235.

inciples 235. These then are all the modes, as well major Principles  
Compo- as minor. Those which are crowded with sharps and as minor. Those which are crowded with sharps and  
sition. flats are little practised, as being extremely difficult in execution.

236. From thence it follows,  
1. That when there are neither sharps nor flats at the cleff, it is a token that the piece begins in the major mode of *ut*, or in the minor mode of *la*.

2. That when there is one single sharp, it will always be placed upon *fa*, and that the piece begins in the major mode of *sol*, or the minor of *mi*, in such a manner that it may be sung as if there were no sharp, by singing *fi* instead of *fa*\*, and in singing the tune as if it had been in another cleff. For instance, let there be a sharp upon *fa* in the cleff of *sol* upon the

first line; one may then sing the tune as if there were no sharp: And, instead of the cleff of *sol* upon the first line, let there be the cleff of *ut*; for the *fa*\*, when changed into *fi*, will require that the cleff of *sol* should be changed to the cleff of *ut*, as may be easily seen, See *Transposition*.

This is what we call *transposition* (†).  
237. It is evident, that when *fa*\* is changed into *fi*, *sol* must be changed into *ut*, and *mi* into *la*. Thus *sol* must be changed into *ut*, and *mi* into *la*. Thus modes reducible by transposition, the air has the same melody as if it were in the major mode of *ut*, or in the minor mode of *la*. The major mode then of *sol*, and the minor of *mi*, are by transposition reduced to those of *ut* major, and of *la* minor. It is the same case with all the other modes, as any one may easily be convinced (ccc).  
237

CHAP.

the note is called a *tonic dominant*, or the *dominant of the mode*, or simply a *dominant*; that the fifth beneath the tonic, or what is the same thing, the fourth above that tonic, is called a *sub-dominant*; and in short, that the note which forms a semitone beneath the tonic, and which is a third major from the dominant, is called a *sensible note*. The other notes have likewise in every mode particular names which it is advantageous to know. This a note which is a tone immediately above the tonic, as *re* in the mode of *ut*, and *fi* in that of *la*, is termed a *sub-tonic*; the following note, which is a third major or minor from the tonic, according as the chord is major or minor, such as *mi* in the major mode of *ut*, and *ut* in the minor mode of *la*, is called a *mediant*; in short, the note which is a tone above the dominant, such as *la* in the mode of *ut*, and *fa*\* in that of *la*, is called a *sub-dominant*.

(†) Though our author's account of this delicate operation in music will be found extremely just and compendious; though it proceeds upon simple principles, and comprehends every possible contingency; yet as the manner of thinking upon which it depends may be less familiar to English readers, if not profoundly skilled in music, it has been thought proper to give a more familiar, though less comprehensive, explanation of the manner in which *transposition* may be executed.

It will easily occur to every reader, that if each of the intervals through the whole diatonic series were equal in a mathematical sense, it would be absolutely indifferent upon what note any air were begun, if within the compass of the gammut; because the same equal intervals must always have the same effects. But since, besides the natural semitones, there is another distinction of diatonic intervals into *greater and lesser tones*; and since these vary their positions in the series of an octave, according as the note from whence you begin is placed, that note is consequently the best key for any tune whose natural series is most exactly correspondent with the intervals which that melody or harmony requires. But in instruments whose scales are fixed, notwithstanding the temperament and other expedients of the same kind, such a series is far from being easily found, and is indeed in common practice almost totally neglected. All that can frequently be done is, to take care that the ear may not be sensibly shocked. This, however, would be the case, if, in transposing any tune, the situation of the semitones, whether natural or artificial, were not exactly correspondent in the series to which your air must be transposed, with their positions in the scale from which you transpose it. Suppose, for instance, your air should begin upon *ut* or C, requiring the natural diatonic series through the whole gammut, in which the distance between *mi* and *fa*, or E and F, as also that between *fi* and *ut*, or B and C, is only a semitone. Again, suppose it necessary for your voice, or the instrument on which you play, that the same air should be transposed to *sol* or G, a fifth above its former key; then because in the first series the intervals between the third and the fourth, seventh and eighth notes, are no more than semitones, the same intervals must take the same places in the octave to which you transpose. Now, from *sol* or G, the note with which you propose to begin, the three tones immediately succeeding are full; but the fourth, *ut* or C, is only a semitone; it may therefore be kept in its place. But from *fa* or F, the seventh note above, to *sol* or G the eighth, the interval is a full tone, which must consequently be redressed by raising your *fa* a semitone higher. Thus the situations of the semitonic intervals in both octaves will be correspondent; and thus, by conforming the positions of the semitones in the octave to which you transpose, with those in the octave in which the original key of the tune is contained, you will perform your operation with as much success as the nature of fixed scales can admit: But the order in which you must proceed, and the intervals required in every mode, are minutely and ingeniously delineated by our author.

(ccc) Two sharps, *fa*\* and *ut*\*, indicate the major mode of *re*, or the minor of *fi*; and then, by transposition, the *ut*\* is changed into *fi*, and of consequence, *re* into *ut*, and *fi* into *la*.

Three sharps, *fa*\* *ut*\* *sol*\*, indicate the major mode of *la*, or the minor of *fa*\*; and it is then *sol*\*, which must be changed into *fi*, and of consequence *la* into *ut*, and *fa*\* into *la*.

Four sharps, *fa*\* *ut*\* *sol*\* *re*\*, indicate the major mode of *mi*, or the minor of *ut*\*; then the *re*\* is changed into *fi*, and of consequence *mi* into *ut*, and *ut*\* into *la*.

Five sharps, *fa*\* *ut*\* *sol*\* *re*\* *la*\*, indicate the major mode of *fi*, or the minor of *sol*\*; *la* then is changed into *fi*, and of consequence *fi* into *ut*, and *sol*\* into *la*.

Six sharps, *fa*\* *ut*\* *sol*\* *re*\* *la*\* *mi*\*, indicate the major mode of *fa*\*; *mi*\* then is changed into *fi*, and of consequence *fa*\* into *ut*.

Six flats, *fi* *mi* *re* *ut* *la* *fi*, indicate the minor mode of *mi*; *ut* is changed into *fa*, and of consequence *mi* into *la*.

Five

CHAP. XIII. To find the Fundamental Basi of a given Modulation.

\* 33  
Method of finding a fundamental basi to a given air not difficult, and why.

238. As we have reduced to a very small number the rules of the fundamental basi, and those which in the treble ought to be observed with relation to this basi, it should no longer be difficult to find the fundamental basi of a given modulation, nay, frequently to

Five flats, *si b mi b la b re b sol b*, indicate the major mode of *re b*, or the minor mode of *si b*; then the *si b* is changed into *fa*, and of consequence the *re b* into *ut*, and the *sol b* into *la*.

Four flats, *si b mi b la b re b*, indicate the major mode of *la b*, or the minor mode of *fa*; *re b* then is changed into *fa*, and of consequence *la b* into *ut*, and *fa* into *la*.

Three flats, *si b mi b la b*, indicate the major mode of *mi b*, or the minor of *ut*; the *la b* then is changed into *fa*, and of consequence *mi b* into *ut*, and the *sol* into *la*.

Two flats, *si b mi b*, indicate the major mode of *sol*, or the minor of *fa*; *mi b* then is changed into *fa*, and of consequence *si b* into *ut*, and the *fa* into *la*.

One flat, *si b*, indicates the major mode of *fa*, or the minor mode of *re*, and *si b* is changed into *fa*; of consequence the *fa* is changed into *ut*, and the *re* into *la*.

All the major modes then may be reduced to that of *ut*, and the modes minor to that of *la* minor.

It only remains to remark, that many musicians, and amongst others the ancient musicians of France, as Lulli, Campra, &c. place one flat less in the minor mode: so that in the minor mode of *re*, they place neither sharp nor flat at the cleff; in the minor mode of *sol*, one flat only; in the minor mode of *ut*, two flats, &c.

This practice in itself is sufficiently indifferent, and scarcely merits the trouble of a dispute. Yet the method which we have here described, according to M. Rameau, has the advantage of reducing all the modes to two; and besides it is founded upon this simple and very general rule, That in the major mode, we must place as many sharps or flats at the cleff, as are contained in the diatonic scale of that mode in ascending; and in the minor mode, as many as are contained in that same scale in descending.

However this be, I here present you with a rule for transposition, which appears to me more simple than the rule in common use.

For the Sharps.

Suppose *sol*, *re*, *la*, *mi*, *si*, *fa*, and change *sol* into *ut* if there is one sharp at the cleff, *re* into *ut* if there are two sharps, *la* into *ut* if there are three, &c.

For the Flats.

Suppose *fa*, *si*, *mi*, *la*, *re*, *sol*, and change *fa* into *ut* if there is only one flat at the cleff, *si* into *ut* if there are two flats, *mi* into *ut* if there are three, &c.

(DDDD) We often say, that we are upon a particular key, instead of saying that we are in a particular mode. The following expressions therefore are synonymous; such a piece is in *ut* major, or in the mode of *ut* major, or in the key of *ut* major.

We have seen that the diatonic scale or gammut of the Greeks was *la si ut re mi fa sol la*, (art. 49.) A method has likewise been invented of representing each of the sounds in this scale by a letter of the alphabet; *la* by A, *si* by B, *ut* by C, &c. It is from hence that these forms of speaking proceed: Such a piece is upon A, with *mi*, *la*, and its third minor; or, simply, it is upon A, with *mi*, *la*, and its minor; such another piece upon C, with *sol*, *ut*, and its third major; or, simply, upon C, with *sol*, *ut*, and its major; to signify that the one is in the mode of *la* minor, or that the other is in that of *ut* major; this last manner of speaking is more concise, and on this account it begins to become general.

They likewise call the cleff of *ut* *fa F*, the cleff of *re* *sol G*, &c. to denominate the cleff of *fa*, the cleff of *sol*, &c.

They say likewise to take the A *mi* *la*, to give the A *mi* *la*; that is to say, to take the union of a certain note called *la* in the harpichord, which *la* is the same that occupies the fifth line, or the highest line in the first cleff of *fa*. This *la* divides in the middle the two octaves which subsist (note *ra*) between the *sol* which occupies the first line in the cleff of *sol* upon that same line, and that *sol* which occupies the first line in the cleff of *fa* upon the fourth; and as it possesses (if we may speak so) the middle station between the sharpest and lowest sounds, it has been chosen to be the found with relation to which all the voices and instruments ought to be tuned in a concert (§).

(§) Thus far our author; and though the note is no more than an illustration of the technical phraseology in his native language, we did not think it consistent with the fidelity of a translation to omit it. We have little reason to envy, and still less to follow, the French in their abbreviations of speech; the native energy of our tongue supercedes this necessity in a manner so effectual, that, in proportion as we endeavour to become succinct, our style, without the smallest sacrifice of perspicuity, becomes more agreeable to the genius of our language: whereas, in French, laconic diction is equally ambiguous and disagreeable. Of this we cannot give a more flagrant instance than the note upon which these observations are made, in its original. We must, however, follow the author's example, in reciting a few technical phrases upon the same subject, which occur in our language, and which, if we are not mistaken, will be found equally concise, at the same time that they are more natural and intelligible. When we mean to express the fundamental note of that series within the diatonic octave which any piece of music demands, we call that note the *key*. When we intend to signify its mode, whether major or minor, we denominate the harmony *sharp* or *flat*. When in a concert we mean to try how instruments are in tune by that note upon which, according to the genius of each particular instrument, they may best agree in union, we desire the musicians who join us to found A.

239. It



Principles  
of Composi-  
tion.234  
difficulty of  
distinguishing  
general  
rules for  
ascertainingthe mode of  
melody  
whose funda-  
mental  
bass is  
ought.234  
reasons  
why one  
may pro-  
ceed with-  
out the  
knowledgeof the  
mode, and  
how he  
may be  
prevented  
from devi-  
ating in  
composi-  
tion.235  
Knowledge  
of the mode  
in begin-  
ning a piece  
is indispens-  
able, and  
why.236  
investiga-  
tion of the  
mode con-  
tinued.237  
Means by  
which the  
modes may  
be deter-  
mined.

239. It is of the greatest utility in searching for the fundamental bass, to know what is the tone or mode of the melody to which that bass should correspond. But it is difficult in this matter to assign general rules, and such as are absolutely without exception, in which nothing may be left that appears indifferent or discretionary; because sometimes we seem to have the free choice of referring a particular melody either to one mode or another. For example, this melody *sol ut* may belong to all the modes, as well major as minor, in which *sol* and *ut* are found together; and each of these two sounds may even be considered as belonging to a different mode.

240. For what remains, one may sometimes, as it should seem, operate without the knowledge of the mode, for two reasons: 1. Because, since the same sounds belong to several different modes, the mode is sometimes considerably undetermined; above all, in the middle of a piece, and during the time of one or two bars. 2. Without giving ourselves much trouble about the mode, it is often sufficient to preserve us from deviating in composition, if we observe in the simplest manner the rules above prescribed (Ch. VI.) for the procedure of the fundamental bass.

241. In the mean time, it is above all things necessary to know in what mode we operate at the beginning of the piece, because it is indispensable that the fundamental bass should begin in the same mode, and that the treble and bass should likewise end in it; nay, that they should even terminate in its fundamental note, which in the mode of *ut* is *ut*, and *la* in that of *la*, &c. Besides, in those passages of the modulation where there is a cadence, it is generally necessary that the mode of the fundamental bass should be the same with that of the part to which it corresponds.

242. To know upon what mode or in what key a piece commences, our inquiry may be entirely reduced to distinguish the major mode of *ut* from the minor of *la*. For we have already seen (art. 236. and 237.), that all the modes may be reduced to these two, at least in the beginning of a piece. We shall now therefore give a detail of the different means by which these two modes may be distinguished.

1. From the principal and characteristic sounds of the mode, which are *ut mi sol* in the one, and *la ut mi* in the other; so that if a piece should, for instance,

begin thus, *la ut mi la*, it may be almost constantly concluded, that the tone or mode is in *la* minor, although the notes *la ut mi* belong to the mode of *ut*.

2. From the sensible note, which is *fi* in the one, and *sol* in the other; so that if *sol* appears in the first bars of a piece, one may be certain that he is in the mode of *la*.

3. From the adjuncts of the mode, that is to say, the modes of its two fifths, which for *ut* are *fa* and *sol*, and *re* and *mi* for *la*. For example, if after having begun a melody by some of the notes which are common to the modes of *ut*, and of *la*, (as *mi re mi fa mi re ut fi ut*), I should afterwards find the mode of *sol*, which I ascertain by the *fa*%, or that of *fa* which I ascertain by the *fi* or *ut*%, I may conclude that I have begun in the mode of *ut*: but if I find the mode of *re*, or that of *mi*, which I ascertain by *fi*%, *ut*%, or *re*%, &c. I conclude from thence that I have begun in the mode of *la*.

4. A mode is not for ordinary deserted, especially in the beginning of a piece; but that we may pass into one or other of these modes which are most relative to it, which are the mode of its fifth above, and that of its third below, if the original mode be major, or of its third above if it be minor. Thus, for instance, the modes which are most intimately relative to the major mode of *ut*, are the major mode of *sol*, and that of *la* minor. From the mode of *ut* we commonly pass either into the one or the other of these modes; so that we may sometimes judge of the principal mode in which we are, by the relative mode which follows it, or which goes before it, when these relative modes are decisively marked. For what remains, besides these two relative modes, there are likewise two others into which the principal mode may pass, but less frequently, viz. the mode of its fifth below, and that of its third above, as *fa* and *mi* for the mode of *ut* (EEEE).

5. The modes may still be likewise distinguished by the cadences of the melody. These cadences ought to occur at the end of every two, or at most of every four bars, as in the fundamental bass: now the cadence of the fundamental bass which is most suitable to these closes \*, is always easy to be found. For the sounds which occur in the treble may be consulted M. Rameau, p. 54. of his *Nouveau Systeme de Musique theorique et pratique* (FFFF).

\* See Ca-  
dence.

( h )

When

(EEEE) It is certain that the minor mode of *mi* has an extremely natural connection with the mode of *ut*, as has been proved (art. 92.) both by arguments and by examples. It has likewise appeared in the note upon the art. 93. that the minor mode of *re* may be joined to the major mode of *ut*; and thus in a particular sense, this mode may be considered as relative to the mode of *ut*: but it is still less so than the major modes of *sol* and *fa*, or than those of *la* and *mi* minor; because we cannot immediately, and without licence, pass in a fundamental bass from the perfect minor chord of *ut* to the perfect minor chord of *re*; and if you pass immediately from the major mode of *ut*, to the minor mode of *re* in a fundamental bass, it is by passing, for instance, from the tonic *ut*, or from *ut mi sol ut*, to the tonic dominant of *re*, carrying the chord *la ut mi sol*, in which there are two sounds, *mi sol*, which are found in the preceding chord; or otherwise from *ut mi sol ut* to *sol fi b re mi*, a chord of the sub-dominant in the minor mode of *re*; which chord has likewise two sounds, *sol mi*, in common with that which went immediately before it.

(FFFF) All these different manners of distinguishing the modes ought, if we may speak so, to give mutual light and assistance one to the other. But it often happens, that one of these signs alone is not sufficient to determine the mode, and may even lead to error. For example, if a piece of music begins with these three notes, *mi ut sol*, we must not with too much precipitation conclude from thence that we are in the major mode of *ut*, although these three sounds, *mi ut sol*, be the principal and characteristic sounds in the major mode of *ut*; we may be in the minor mode of *mi*, especially if the note *mi* should be long. You may see an example in the fourth act of *Zoroaster*, where the first air sung by the priests of Arimanes begins thus with two times, *sol mi b fi b*, each of these notes being a crotchet. This air is in the minor mode of *sol*, and not in the major mode of *mi* b, as one would at first be tempted to believe it. Now we may be sensible that it is in *sol* minor, by the relative modes which follow, and by the notes where the cadences fall.

Principles  
of Composi-  
tion.

Principles of Composition.

238 Having ascertained the mode, the fundamental bass not difficult.

When a person is once able to ascertain the mode, and can render himself sure of it by the different means which we have pointed out, the fundamental bass will cost little pains. For in each mode there are three fundamental sounds.

1. The tonic of the mode, or its principal found, which carries always the perfect chord major or minor, according as the mode itself is major or minor.

Major mode of UT. *sol si re fa.*  
Minor mode of LA. *la ut mi la.*

2. The tonic dominant, which is a fifth above the tonic, and which, whether in the major or minor mode, always carries a chord of the seventh, composed of a third major followed by two thirds minor.

Tonic dominant.  
Major mode of UT. *sol si re fa.*  
Tonic dominant.  
Minor mode of LA. *mi sol si re.*

3. The sub-dominant, which is a fifth below the tonic, and which carries a chord composed of a third, fifth, and sixth major, the third being either greater or lesser, according as the mode is major or minor.

Sub-dominant.  
Major mode of UT. *fa la ut re.*  
Minor mode of LA. *re fa la si.*

These three sounds, the tonic, the tonic dominant, and the sub-dominant, contain in their chords all the notes which enter into the scale of the mode; so that when a melody is given, it may almost always be found which of these three sounds should be placed in the fundamental bass, under any particular note of the upper part. Yet it sometimes happens that not one of these notes can be used. For example, let it be supposed that we are in the mode of *ut*, and that we find in the melody these two notes *la si* in succession; if we confine ourselves to place in the fundamental bass one of the three sounds *ut sol fa*, we shall find nothing for the sounds *la* and *si* but this fundamental bass *fa sol*; now such a succession as *fa* to *sol* is prohibited by the fifth rule for the fundamental bass, according to which every sub-dominant, as *fa*, should rise by a fifth; so that *fa* can only be followed by *ut* in the fundamental bass, and not by *sol*.

To remedy this, the chord of the sub-dominant *fa la ut re* must be inverted into a fundamental chord of the seventh in this manner, *re fa la ut*; which has been called the double employment (art. 105.) because it is a secondary manner of employing the chord of the sub-dominant. By these means we give to the modulation *la si*, this fundamental bass *re sol*; which procedure is agreeable to rules.

Here then are four chords, *ut mi sol ut*, *sol si re fa*, *fa la ut re*, *re fa la ut*, which may be employed in the major mode of *ut*. We shall find in like manner, for the minor mode of *la*, four chords,

(GGGG) I have said, that they may be reckoned as belonging to this mode, for two reasons: 1. Because, properly speaking, there are only three chords which essentially and primitively belong to the mode of *ut*, viz. *ut* carrying the perfect chord, *fa* carrying that of the sub-dominant, and *sol* that of the tonic dominant, to which we may join the chord of the seventh, *re fa la ut* (art. 105.); but we here regard as extended the series of dominants in question, as belonging to the mode of *ut*, because it preserves in the ear the impression of that mode. 2. In a series of dominants, there are a great many of them which likewise belong to other modes; for instance, the simple dominant *la* belongs naturally to the mode of *sol*, the simple dominant *si* to that of *la*, &c. Thus it is only improperly, and by way of extension, as I have already said, that we regard here these dominants as belonging to the mode of *ut*.

*la ut mi la, mi sol si re,*  
*re fa la si, si re fa la.*

And in this mode we sometimes change the last of these chords into *si re fa*, substituting the *fa* for *fa si*. For instance, if we have this melody in the minor mode of *la*, *mi fa sol la*, we would cause the first note *mi* to carry the perfect chord *la ut mi la*, the second note *fa* to carry the chord of the seventh *si re fa la*, the third note *sol* the chord of the tonic dominant *mi sol si re*, and in short, the last the perfect chord *la ut mi la*.

On the contrary, if this melody is given always in the minor mode *la la sol la*, the second *la* being syncopated, it might have the same bass as the modulation *mi fa sol la*; with this difference alone, that *fa si* might be substituted for *fa* in the chord *si re fa la*, the better to mark out the minor mode.

Besides these chords which we have just mentioned, and which may be regarded as the principal chords of the mode, there are still a great many others; for example, the series of dominants,

*ut la re sol ut fa si mi la re sol ut*, which are terminated equally in the tonic *ut*, either entirely belong, or at least may be reckoned as belonging (GGGG) to the mode of *ut*; because none of these dominants are tonic dominants except *sol*, which is the tonic dominant of the mode of *ut*; and besides, because the chord of each of these dominants forms no other sounds than such as belong to the scale of *ut*.

But if I were to form this fundamental bass,

*7 7 7 7b*  
*ut la re sol ut,*

considering the last *ut* as a tonic dominant in this manner, *ut mi sol si*; the mode would then be changed at the second *ut*, and we should enter into the mode of *fa*; because the chord *ut mi sol si* indicates the tonic dominant of the mode of *fa*; besides, it is evident that the mode is changed, because *si* does not belong to the scale of *ut*.

In the same manner, were I to form this fundamental bass

*7 7 7 6*  
*ut la re sol ut,*

considering the last *ut* as a tonic dominant, in this manner, *ut mi sol la*; this last *ut* would indicate the mode of *sol*, of which *ut* is the sub-dominant.

In like manner, still, if in the first series of dominants, I caused the first *re* to carry the third major, in this manner, *re fa la ut*; this *re* having become a tonic dominant, would signify to me the major mode of *sol*; and the *sol* which should follow it, carrying the chord *si re fa*, would relapse into the mode of *ut*, from whence we had departed.

Finally, in the same manner, if in this series of dominants, one should cause *si* to carry *fa* in this manner, *si re fa la*; this *fa* would show that we had departed from the mode *ut*, to enter into that of *sol*.

From

Principles of Composition.

Principles of Composition.

219 rule for covering the ranges of voice.

From hence it is easy to form this rule for discovering the changes of mode in the fundamental bas.

1. When we find a tonic in the fundamental bas, we are in the mode of that tonic; and the mode is major or minor, according as the perfect chord is major or minor.

2. When we find a sub-dominant, we are in the mode of the fifth above that sub-dominant; and the mode is major or minor, according as the third in the chord of the sub dominant is major or minor.

3. When we find a tonic dominant, we are in the mode of the fifth below that tonic dominant. As the tonic dominant carries always the third major, one cannot be secure by the assistance of this dominant alone, whether the mode be major or minor: but it is only necessary for the composer to cast his eye upon the following note, which must be the tonic of the mode in which he is; by the third of this tonic he will discover whether the mode be major or minor.

243. Every change of the mode supposes a cadence; and when the mode changes in the fundamental bas, it is almost always either after the tonic of the mode in which we have been, or after the tonic dominant of that mode, considered then as a tonic by favour of a close which ought necessarily to be found in that place: Whence it happens that cadences in a melody for the most part preface a change of mode which ought to follow them.

244. All these rules, joined with the table of modes which we have given (art. 234.), will serve to discover in what mode we are in the middle of a piece, especially in the most essential passages, as cadences (ННН). I here subjoin the folioloquy of Armida, with the

continued and fundamental basses. The changes of the mode will be easily distinguished in the fundamental bas, by the rules which we have just given at the end of the article 242. This folioloquy will serve for a lesson to beginners. M. Rameau quotes it in his *New System of Music*, as an example of modulation highly just and extremely simple. (See Plate V and the following. (1111).

CHAP. XIV. Of the Chromatic and Enharmonic.

245. WE call that melody *chromatic* which is composed of several notes in succession, whether rising or descending by semitones. (See LXXXVIII. and LXXXIX.)

246. When an air is chromatic in descending, the most natural and ordinary fundamental bas is a concatenated series of tonic dominants; all of which follow by one another in descending by a fifth, or which is the same thing, in rising by a fourth. See LXXXVIII. (1111).

247. When the air is chromatic in ascending, one tal bas may form a fundamental bas by a series of tonics and of tonic dominants, which succeed one another alternately by the interval of a third in descending, and of a fourth in ascending, (see LXXXIX.) There are many other ways of forming a chromatic air, whether in rising or descending; but these details in an elementary essay are by no means necessary.

248. With respect to the enharmonic, it is very rarely put in practice; and we have explained its formation in the first book, to which we refer our readers. We shall content ourselves with saying, that, in the beautiful folioloquy of the fourth act of *Dardanus*, at the words *lieux funestes*, &c. "fatal places, &c." we find an example of the enharmonic; an example of the diatonic enharmonic

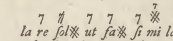
(НННН) Two modes are so much more intimately relative as they contain a greater number of sounds common to both; for example, the minor mode of *ut* and the major of *sol*, or the major mode of *ut* and the minor of *la*: on the contrary, two modes are less intimately relative as the number of sounds which they contain as common to both is smaller; for instance, the major mode of *ut* and the minor of *fa*, &c.

When you find yourself led away by the current of the modulation, that is to say, by the manner in which the fundamental bas is constituted, into a mode remote from that in which the piece was begun, you must continue in it but for a short time, because the ear is always impatient to return to the former mode.

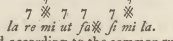
(1111) It is extremely proper to remark, that we have given the fundamental, the continued bas, and in general the modulation of this folioloquy, merely as a lesson in composition extremely suitable to beginners; not that we recommend the folioloquy in itself as a model of expression. Upon this last object what we have said may be seen in what we have written concerning the liberties to be taken in music, Vol. IV. p. 435. of our Literary Miscellany. It is precisely because this folioloquy is a proper lesson for initiates, that it would be a bad one for the mature and ingenious artist. The novice should learn tenaciously to observe his rules; the man of art and genius ought to know on what occasions and in what manner they may be violated when this expedient becomes necessary.

(1111) We may likewise give to a chromatic melody in descending, a fundamental bas, into which may enter chords of the seventh and of the diminished seventh, which may succeed one another by the intervals of a false fifth and a fifth redundant: thus in the Example XC. where the continued bas descends chromatically, it may easily be seen that the fundamental bas carries successively the chords of the seventh and of the seventh diminished, and that in this bas there is a false fifth from *re* to *sol*, and a fifth redundant from *sol* to *ut*.

The reason of this licence is, as it appears to me, because the chord of the diminished seventh may be considered as representing (art. 221.) the chord of the tonic dominant; in such a manner that this fundamental bas



(see Example XCI.) may be considered as representing (art. 116.) that which is written below,



Now this last fundamental bas is formed according to the common rules, unless that there is a broken cadence from *re* to *mi*, and an interrupted cadence from *mi* to *ut*, which are licences (art. 213 and 214.)

Principles  
of Compo-  
sition.

enharmonic in the trio of the *Fatal Sisters*, in *Hippolitus* and *Arícia*, at the words, *Ou cours-tu malheureux*, "Whither, unhappy, dost thou run?" and that there are no examples of the chromatic enharmonic, at least in our French operas. M. Rameau had imitated an earthquake by this species of music, in the second act of the *Gallant Indians*; but he informs us, that in 1735 he could not cause it to be executed by the band. The trio of the *Fatal Sisters* in *Hippolitus* has never been tried in the opera as it is composed. But M. Rameau asserts, (and we have heard it elsewhere) by people of taste, before whom the piece was performed), that the trial had succeeded when made by able hands that were not mercenary, and that its effect was astonishing.

See *Design*.

244  
Design,  
what.

#### CHAP. XV. Of Design, Imitation, and Fugue.

249. IN music, the name of *design*, or *subject*, is generally given to a particular air or melody, which the composer intends should prevail through the piece; whether it is intended to express the meaning of words to which it may be set, or merely inspired by the impulse of taste and fancy. In this last case, design is distinguished into *imitation* and *fugue*.

See *Imi-  
tation*.

245  
Imitation,  
what.

\* See *Air,  
Canon,  
Fugue*.

250. *Imitation* consists in causing to be repeated the melody of one, or of several bars in one single part, or in the whole harmony, and in any of the various modes that may be chosen. When all the parts absolutely repeat the same air \* or melody, and beginning one after the other, this is called a *canon*. *Fugue* consists in alternately repeating that air in the treble, and in the bass, or even in all the parts, if there are more than two.

246  
Principal  
rules for  
composing  
in several  
parts.

251. Imitation and fugue are sometimes conducted by rules merely deducible from taste, which may be seen in the 332<sup>d</sup> and following pages of M. Rameau's *Treatise on Harmony*; where will likewise be found a detail of the rules for composition in several parts. The chief rules for composition in several parts are, that the discords should be found, as much as possible, prepared and resolved in the same part; that a discord should not be heard at the same time in several parts, because its harshness would disgust the ear; and that in no particular part there should be found two octaves or two fifths in succession (MMMM) with respect to the bass. Musicians, however, do not hesitate sometimes to violate this precept, when taste or occasion require. In music, as in all the other fine arts, it is the business of the artist to assign and to observe rules; the province of men who are adorned with taste and genius is to find the exceptions.

#### CHAP. XVI. Definitions of the Different Airs.

252. WE shall finish this treatise by giving in a few words the characteristic distinctions of the different airs to which names have been given, as *chacon*, *minuet*, *rigadon*, &c.

The *chacon* is a long piece of music, containing three times in each bar, of which the movement is regular, and the bars sensibly distinguished. It consists of several couplets, which are varied as much as possible.

(MMMM) Yet there may be two fifths in succession, provided the parts move in contrary directions, or, in other words, if the progress of one part be ascending, and the other descending; but in this case they are not properly two fifths, they are a fifth and a twelfth; for example, if one of the parts in descending should sound *fa* re, and the other *ut la* in rising, *ut* is the fifth of *fa*, and *la* the twelfth of *re*.

Principles  
of Compo-  
sition.

Formerly the bass of the chacon was a *constrained bass*, or regulated by a rhythmus terminating in 4 bars, and proceeding again by the same number; at present composers of this species no longer confine themselves to that practice. The chacon begins, for the most part, not with the perfect time, which is struck by the hand or foot, but with the imperfect, which passes while the hand or foot is elevated.

The *villanelle* is a chacon a little more lively, with its movement somewhat more brisk than the ordinary chacon.

The *passacaille* only differs from a chacon as it is more slow, more tender, and beginning for ordinary with a perfect time.

The *minuet* is an air in triple time, whose movement is regular, and neither extremely brisk nor slow, consisting of two parts or strains, which are each of them repeated; and for which reason they are called by the French *repries*: each strain of the minuet begins with a time which is struck, and ought to consist of 4, of 8, or of 12 bars; so that the cadences may be easily distinguished, and recur at the end of each 4 bars.

The *sarabando* is properly a slow minuet; and the *courant* a very slow sarabando: this last is no longer in use. The *passépée* is properly a very brisk minuet, which does not begin like the common minuet, with a stroke of the foot or hand; but in which each strain begins in the last of the three times of which the bar consists.

The *loure* is an air whose movement is slow, whose time is marked with  $\frac{6}{4}$ , and where two of the times in which the bar consists are beaten; it generally begins with that in which the foot is raised. For ordinary the note in the middle of each time is shortened, and the first note of the same time pointed.

The *jig* is properly nothing else but a *loure* very brisk, and whose movement is extremely quick.

The *forlana* is a moderate movement, and in a mediocrity between the *loure* and the *jig*.

The *rigadon* has two times in a bar, is composed of two strains, each to be repeated, and each consisting of 4, of 8, or of 12 bars: its movement is lively; each strain begins, not with a stroke of the foot, but at the last note of the second time.

The *bourée* is almost the same thing with the *rigadon*.

The *gavotte* has two times in each bar, is composed of two strains, each to be repeated, and each consisting of 4, of 8, or of 12 bars: the movement is sometimes slow, sometimes brisk; but never extremely quick, nor very slow.

The *tambourin* has two strains, each to be repeated, and each consisting of 4, of 8, or of 12 bars, &c. Two of the times that make up each bar are beaten, and are very lively; and each strain generally begins in the second time.

The *musette* consists of two or three times in each bar; its movement is neither very quick nor very slow; and for its bass it has often no more than a single note, which may be continued through the whole piece.

*Gloss.* MUSIC. See HARMONICA.

**MUSK**, a very strong-scented substance found under the belly of an East India animal. See MOSCHUS.

According to Tavernier, the best and greatest quantities of musk come from the kingdom of Boutan, from whence it is carried for sale to Patna, the chief town of Bengal. After killing the animal, the peasants cut off the bag, which is about the size of an egg, and is situated nearer the organs of generation than the navel. They next take out the musk, which has then the appearance of clotted blood. When they want to adulterate it, they put a mass of the animal's blood and liver into the place of the musk they had extracted. In two or three years this mixture produces certain small animals which eat the good musk; so that, when opened, a great consumption is perceived. Others, after extracting a portion of the musk, put in small pieces of lead to augment the weight. The merchants who transport the musk to foreign countries are less averse to this trick than the former; because in this case none of the animals above-mentioned are produced. But the deceit is still worse to discover, when, of the skin taken from the belly of a young animal, they make little bags, which they sew so dextrously with threads of the same skin, that they resemble genuine bags. Those they fill with what they take out of the genuine bags, and some fraudulent mixture, which it is extremely difficult for the merchants to detect. When the bags are sewed immediately on their being cut, without allowing any part of the odour to dissipate in the air, after they have abstracted as much of the musk as they think proper, if a person applies one of these bags to his nose, blood will be drawn by the mere force of the odour, which must necessarily be weakened or diluted in order to render it agreeable without injuring the brain. Our author brought one of the animals with him to Paris, the odour of which was so strong, that it was impossible for him to keep it in his chamber. It made every head in the house giddy; and he was obliged to put it in a barn, where the servants at last cut away the bag: the skin, notwithstanding, always retained a portion of the odour. The largest musk-bag seldom exceeds the size of a hen's egg, and cannot furnish above half an ounce of musk: three or four of them are sometimes necessary to afford a single ounce. In one of his voyages to Patna, Tavernier purchased 1663 bags, which weighed 1557 ounces and a half; and the musk, when taken out of the bags, weighed 452 ounces.

Musk affords the strongest of all known odours. A small bit of it perfumes a large quantity of matter. The odour of a small particle extends through a considerable space. It is likewise so fixed and permanent, that at the end of several years it seems to have lost no part of its activity. When it comes to us it is dry, with a kind of unctuousness, of a dark reddish-brown or rusty blackish colour, in small round grains, with very few hard black clots, and perfectly free from any sandy or other visible foreign matter. If chewed, and rubbed with a knife on paper, it looks smooth, bright, yellowish, and free from bitterness. Laid on a red-hot iron, it catches flame, and burns almost entirely away, leaving only an exceeding small quantity

VOL. VII.

1

of light greyish ashes: if any earthy substances have been mixed with the musk, the quantity of the residuum will readily discover them.

Musk has a bitterish subacid taste; a fragrant smell, agreeable at a distance, but when smelt near to, so strong as to be disagreeable unless weakened by the admixture of other substances. If a small quantity be infused in spirit of wine in the cold for a few days, it imparts a deep, but not red tincture: this, though it discovers no great smell of the musk, is nevertheless strongly impregnated with its virtues; a single drop of it communicates to a whole quart of wine a rich musky flavour. The degree of flavour which a tincture drawn from a known quantity of musk communicates to vinous liquors, is perhaps one of the best criteria for judging of the goodness of this commodity. Neuman informs us, that spirit of wine dissolves ten parts out of thirty of musk, and that water takes up twelve; that water elevates its smell in distillation, whilst pure spirit brings over nothing.

Musk is a medicine of great esteem in the eastern countries; among us, it has been for some time pretty much out of use, even as a perfume, on a supposition of its occasioning vapours, &c. in weak females and persons of a sedentary life. It appears, however, from late experience, to be, when properly managed, a remedy of good service even against those disorders which it has been supposed to produce. Dr Wall has communicated (in the *Philosoph. Transactions*, n<sup>o</sup> 474.) an account of some extraordinary effects of musk in convulsive and other diseases, which have too often baffled the force of medicine. The doctor observes, that the smell of perfumes is often of service, where the substance, taken inwardly and in considerable quantity, produces the happiest effects; that two persons, labouring under a subleptus tendinum, extreme anxiety, and want of sleep, from the bite of a mad dog, by taking two doses of musk, each of which was sixteen grains, were perfectly relieved from their complaints. He likewise observes, that convulsive hiccups, attended with the worst symptoms, were removed by a dose or two of ten grains; and that in some cases, where this medicine could not, on account of strong convulsions be administered to the patient by the mouth, it proved of service when injected as a glyster. He likewise adds, that under the quantity of six grains, he never found much effect from it; but that, taken to ten grains and upwards, it never fails to produce a mild diaphoresis, without at all heating or giving any uneasiness: that, on the contrary, it eases pain, raises the spirits; and that, after the sweat breaks out, the patient usually falls into a refreshing sleep: that he never met with any hysterical person, how averse soever to perfumes, but could take it, in the form of a bolus, without inconvenience. To this paper is annexed an account of some farther extraordinary effects of musk, observed by another gentleman. Repeated experience has since confirmed its efficacy in these disorders. The author of the *New Dispensatory* says, he has frequently given it with remarkable success; and sometimes increased the dose as far as twenty grains every four hours, with two or three spoonfuls of the musk julep between. The julep is the only official preparation of it.

*Musk-Animal.* See MOSCHUS.

29 S

Musk-

Musket  
Musket.

MUSK-Rat, in zoology. See CASTOR.  
MUSKET, a fire arm born on the shoulder, and used in war. See GUN, *par. ut.*

MUSKETOON, a kind of short thick musket, whose bore is the 38th part of its length: it carries five ounces of iron, or seven and an half of lead, with an equal quantity of powder. This is the shortest kind of blunderbusses.

MUSLIN, a fine sort of cotton-cloth, which bears a downy knot on its surface. There are several sorts of muslins brought from the East Indies, and more particularly from Bengal; such as dooras, bettelles, mulmls, tanjebbs, &c.

MUSONIUS, (Caius Rufus) a Stoic philosopher of the second century, was banished into the island of Gyare, under the reign of Nero, for criticising the manners of that prince; but was recalled by the emperor Vespasian. He was the friend of Apollonius Tyanæus, and the letters that passed between them are still extant.

MUSQUETOE. See CULEX, in the APPENDIX.  
MUSSÜLMAN, or MUSULMAN, a title by which the Mahometans distinguish themselves; signifying, in the Turkish language, "true believer, or orthodox." See MAHOMETANISM.

In Arabic, the word is written *Moslem, Mosleman, or Moslivan*. The appellation was first given to the Saracens; as is observed by Leunclavius.—There are two kinds of Mussulmans, very averse to each other; the one called *Sonnites*, and the other *Shiites*.—The Sonnites follow the interpretation of the Alcoran given by Omar; the Shiites are the followers of Ali. The subjects of the king of Persia are Shiites; and those of the grand signior, Sonnites. See SONNA, and ALCORAN.

Some authors will have it, that the word *Mussulman* signifies *saved*, that is, predestinated; and that the Mahometans give themselves the appellation, as believing they are all predestinated to salvation.—Martinius is more particular as to the origin of the name; which he derives from the Arabic *مخلص, musfelens*, "saved, snatched out of danger:" the Mahometans, he observes, establishing their religion by fire and sword, massacred all those who would not embrace it, and granted life to all that did, calling them *Mussulmans*, *q. d. erepti à periculo*; whence the word, in course of time, became the distinguishing title of all those of that sect, who have affixed to it the signification of *true believer*.

MUST, MUSTUM, sweet wine newly pressed from the grape; or the new liquor pressed from the fruit before it has worked or fermented. See WINE.

MUSTELA, in zoology, a genus of quadrupeds of the order of fere. There are six erect, sharp, distinct teeth in the upper jaw, and an equal number in the under jaw, but blunter and closer together, and two of them are situated a little farther within the mouth; and the tongue is smooth. There are 11 species, *viz.*

1. The lutris, or sea-otter, hath palmated feet, and the tail about one-fourth of the length of the body; the hair thick, long, and excessively black and glossy: beneath that is a soft down; the colour sometimes varies to silvery. The biggest of these animals weigh 70 or 80 pounds. They inhabit, in vast abundance, the

Mussels.

coasts of Kamtschatka, and the parts of America opposite to it, discovered by the Russians: it is also met with in a most remote part of the continent of America, along the rivers of Brazil and Paraguay, and in the Oronoko. It is a harmless animal; very affectionate to its young, inasmuch that it will pine to death at the loss of them, and die on the very spot where they have been taken from it. Before the young can swim, they carry them in their paws, lying in the water on their backs: they run very swiftly; swim often on their back, their sides, and even in a perpendicular posture: are very sportive; embrace, and kiss each other: they inhabit the shallows, or such places as abound with sea-weeds; feed on lobsters, and other shell-fish, as well as sepia and common fishes: they breed but once a-year, and have but one young one at a time, suckle it for a year, and bring it on shore. They are dull-sighted, but quick-scented: are hunted for their skins; which are of great value, being sold to the Chinese for 70 or 80 rubles a-piece; each skin weighs 3½ lib. The young are reckoned very delicate meat, scarce to be distinguished from a sucking lamb. The cry of this creature is nearly similar to a young dog; and it is sometimes interrupted by another cry similar to that of the faki or fox-tailed monkey. It may be nourished with the flour of manioc diluted in water.

2. The lutra, or otter, has palmated feet, the tail one half the length of the body; the whole colour is a deep brown, except two small spots on each side of the nose, and another below the chin; the legs are short and thick, and loosely joined to the body: the length from the nose to the tail is 23 inches. The otter inhabits all parts of Europe, the north and north-east of Asia, even as far as Kamtschatka; it abounds in North America, particularly in Canada, from whence the most valuable furs of this kind are brought. He is a voracious animal, but fonder of fish than of flesh: he doth not willingly quit the margins of rivers or lakes, and often depopulates fish-ponds; but if fish happens to fail, he makes excursions on land, and preys on lambs and poultry. It is observable, that the otter always swims against the stream to meet its prey; and two of them, it is said, will hunt a salmon in concert. One stations itself above, and the other below the place where the fish lies, and continue chasing it incessantly, till the creature, quite wearied out, becomes their prey. Sometimes the otter preys in the sea, but not far from shore. It hath been observed, however, in the Orkneys to bring in cod, congers, &c. Properly speaking, he is not an amphibious animal; for, like other terrestrial creatures, he requires the aid of frequent respiration. When in pursuit of a fish, if he chances to be entangled in a net, he drowns; and we perceive that he has not had time to cut a sufficient quantity of the meshes to effectuate his escape. For want of fishes, crabs, frogs, or other animal-food, he gnaws the young twigs, and eats the bark of aquatic trees; he likewise eats the young herbage in the spring. The female comes in season in winter, brings forth in March, and the litter consists of three or four. The young otters are less handsome than the old; and M. Buffon looks upon the otters in general to be very stupid animals. He will not allow them the capacity and instinct commonly ascribed to them by other naturalists; such

Plate  
CL. XXXIV.  
fig. 4.

such as that of always ascending the rivers, in order to swim the more easily down the current, when loaded with his prey; of sitting up, and flooring his house to exclude the water; and of hoarding a store of fishes in case of a scarcity; and lastly, of being easily tamed, of fishing for his master, and even bringing the fish into the kitchen. "All I know (says our author) is, that the otters dig no habitations for themselves; that they take possession of the first hole they find, under the roots of poplars or willows, in the clefts of rocks, and even in piles of floating wood; that they deposit their young on beds made of twigs and herbs; that we find, in their habitations, heads and bones of fishes; that they often change their places of abode; that they banish their young at the end of six weeks or two months; that those I endeavoured to tame attempted to bite, though they were only taking milk, and unable to eat fish; that, some days after, they became more gentle, perhaps because they were weak or sick; that, so far from being easily accustomed to a domestic life, all of them which I attempted to bring up died young; that the otter is naturally of a savage and cruel disposition; that when he gets into a fish-pond, he is equally destructive as the pole-cat in a hen-house; that he kills many more fishes than he can eat, and carries one off in his mouth."

On the other hand, Mr Pennant tells us, that the otter shows great sagacity in forming its habitation: it burrows underground on the banks of some river or lake: it always makes the entrance of its hole under water; working upwards to the surface of the earth, and forming, before it reaches the top, several holes or lodges, that, in case of high floods, it may have a retreat; for no animal affects lying drier at top: it makes a minute orifice for the admission of air. It is further observed, that this animal, the more effectually to conceal its retreat, contrives to make even this little air-hole in the middle of some thick bush. Our author also informs us, that the otter is capable of being tamed; that he will follow his master like a dog, and even fish for him, and return with his prey.

Though the otter does not cast his hair, his skin is browner, and feels drier, in winter than in summer; and makes a very fine fur. His flesh has a disagreeable fishy taste. His retreats exhale a noxious odour from the remains of putrid fishes; and his own body has a bad smell. The dogs chase the otter spontaneously, and easily apprehend him when at a distance from water or from his hole. But, when seized, he defends himself; bites the dogs most cruelly, and sometimes with such force as to break their leg-bones, and never quits his hold but with life. The beaver, however, who is not a very strong animal, pursues the otters, and will not allow them to live on the same banks with himself.

Mr Pennant mentions an account of some Newfoundland animals, communicated to him by Mr Banks, which he supposes to have been of the otter kind. He observed, sitting on a rock near the mouth of a river, five animals shaped like Italian grey-hounds, bigger than a fox; of a shining black colour, with long legs, and a long taper tail. They often leaped into the water, and brought up trouts, which they gave to their young which were sitting by them. On perceiving him they all took to the water, and swam a little way from shore,

keeping their heads out of the water, and looking at him. An old furrier said, that he remembered the skin of one fold for five guineas; and that the French often see them in Hare-bay. According to some authors, there are otters in Cayenne which weigh 90 and 100 pounds. They live in the great and unfrequented rivers, and their heads often appear above water. Their cry is heard at great distances; their hair is very soft, but shorter than that of the beaver, and generally of a brown colour. They live upon fish, and eat likewise the grains which fall into the water from the banks of the rivers. In Guiana, according to M. de la Borde, the otters are very numerous along the rivers and marshes where fishes abound. They sometimes appear in such numbers, and are so fierce, that they cannot be approached. They litter in holes which they dig in the banks; they are often tamed and brought up in houses.

3. The lutreola, or small otter, has hairy palmated feet, and a white mouth, the same form with an otter, but thrice as small. It inhabits Poland and the north of Europe; lives on fish, frogs, and water-insects: its fur is very valuable, next to the sable; is caught in Baskiria with dogs and traps; is exceedingly foetid. This is the same animal with the mix of America, which, Mr Collinson tells us, frequents the water like the otter, and very much resembles it in shape and colour, but is less; it leaves its watery haunts to come and rob hen-roosts; it bites off the heads of the poultry, and sucks their blood; when vexed, it has a strong loathsome smell; its length from nose to tail 20 inches, the tail four: is of a shining dark-brown colour. M. Buffon mentions, from M. de la Borde, a kind of otter which he calls the *small fresh-water otter of Cayenne*, and which is only seven inches long from the end of the nose to the extremity of the body. The tail of this small otter has no hair: its length is six inches seven lines, and five lines thick at the origin, diminishing gradually to the extremity, which is white, though the rest of the tail is brown; and, in place of hair, it is covered with a rough granulated skin, like chagreen; it is flat below, and convex above. All the under part of the body and head, as well as the fore-part of the fore-legs, is white. The top and sides of the head and body are marked with large brownish-black spots, and the intervals are of a yellowish grey colour. The black spots correspond on each side of the body, and there is a white spot above each eye.

4. The barbata, or Guinea-weasel, is of a reddish colour; and the toes are not connected with a membrane: he is of a black colour, with coarse hair of the size of a martin; digs an habitation in the earth with his fore-feet, in which he has great strength, and which are much shorter than those behind. It inhabits Guinea, Brasil, and Guiana: when it rubs itself against trees, it leaves behind an unctuous matter that smells of musk. It is very fierce; and, if driven to necessity, will fly at man or beast: it is very destructive to poultry.

5. The gulo, or glutton, is of a dusky red colour, and blackish on the middle of the back: it is a most voracious animal; but very slow of foot, so is obliged to take its prey by surprise. In America it is called the *beaver-eater*; because it watches those animals as they come out of their houses, and sometimes breaks into their habitations and devours them. It often lurks on

trees, and falls on the quadrupeds that pass under; will fasten on a horse, elk, or stag, and continue eating a hole into its body, till the animal falls down with pain, or else will tear out its eyes: no force can disengage it; yet sometimes the deer, in their agony, have been known to destroy the glutton by running its head violently against a tree. This animal also devours the iaiats, or white fox; searches for the traps laid for the fables and other animals, and is often beforehand with the huntsmen, who sustain great loss by the glutton. Authors have pretended, that it feeds voraciously, that at length it is in danger of burbling; and that it is obliged to ease itself of its load, by squeezing it out between two trees: but this is not well authenticated. Mr Buffon acquaints us, that a glutton which he kept for 18 months at Paris, became so tame that it discovered no ferocity, and did not injure any person. "His voracity (says he) has been as much exaggerated as his cruelty. He indeed eat a great deal; but, when deprived of food, he was not importunate. He is two feet two inches long, from the point of the nose to the origin of the tail. The muzzle, and as far as the eye-brows, is black. The eyes are black and small. From the eye-brows to the ears, the hair is a mixture of white and brown. Below the under-jaw, as well as between the fore-feet, the hair is spotted with white. The length of the fore-legs is 11 inches, and that of the hind-legs one foot. The tail, including four inches of hair at its extremity, is eight inches long. The four legs, the tail, and the back, as well as the belly, are black. His fore-feet, from the heel to the extremity of the claws, are three inches nine lines in length: the five claws are very crooked and well separated. The middle claw is an inch and an half in length. He avoids water; and dreads horses, and men dressed in black. He walks by a kind of leap, and eats pretty voraciously. After taking a full meal, he covers himself in his cage with straw. When drinking, he laps like a dog. He utters no cry. After drinking, with his paws he throws the remainder of the water on his belly. He is almost perpetually in motion. If allowed, he would devour more than four pounds of flesh every day. He eats no bread; and devours his food voraciously, and almost without chewing, that he is apt to choke himself."

The glutton is common in most of the northern regions of Europe, and even of Asia; but in Norway, according to Pontoppidan, he is chiefly confined to the diocese of Drontheim. The same author remarks, that the skin of the glutton is very valuable; that he is not shot with fire-arms, to prevent his skin from being damaged; and that the hair is soft, and of a black colour, shaded with brown and yellow. In Siberia the skin is sold for 4s. or 6s.; at Jakutsk for 12s.; and in Kamtschatka still dearer, because the women there dress their hair with its paws, which they esteem a great ornament: the fur is greatly esteemed in Europe; and those produced in the north of Europe and Asia are much preferable to the American kind. In its wild state, Mr Pennant informs us, that the glutton is vastly fierce; a terror both to the wolf and bear, which will not prey upon it when they find it dead; perhaps on account of its being so very fetid that it smells like a pole-cat: it makes a strong resistance when attacked; will tear the flock from the gun, and pull the traps in

which it is caught to pieces: notwithstanding which, it is capable of being tamed, and of learning several tricks. M. Buffon remarks, that though the glutton employs considerable art and address in seizing other animals, he seems to possess no other talents but those which relate to appetite. "It would (says he) appear, that the glutton even wants the common instinct of self-preservation. He allows himself to be approached by men, or comes up to them without betraying the smallest apprehension." This indifference, which seems to be the effect of imbecility, proceeds perhaps from a different cause. It is certain that the glutton is not stupid, since he finds means to satisfy his appetite, which is always vehement and pressing. Neither is he deficient in courage; since he indiscriminately attacks all animals he meets with, and betrays no symptoms of fear at the approach of men. Hence, if he wants attention to himself, it proceeds not from indifference to his own preservation, but from the habit of security. As he lives in a country which is almost desert, he seldom sees man, who are his only enemies. Every time he tries his strength with other animals, he finds himself their superior. He goes about with perfect confidence; and never discovers the smallest mark of fear, which always supposes some experience of weakness. Of this we have an example in the lion, who never turns away from man, unless he has experienced the force of his arms; and the glutton, trailing along the snows of his desert climate, remains always in perfect safety, and reigns, like the lion, not so much by his own strength, as by the weakness of the animals around him.

6. The martes, or martin, is of a blackish yellow colour, with a pale throat, and the toes are not webbed. These animals are found in great numbers in all temperate countries, and even in warm regions, as in Madagascar and the Maldivia islands, and are never seen in high latitudes. The martin has a fine countenance, a lively eye, supple limbs, and a flexible body. His movements are all exceedingly nimble; he rather bounds and leaps than walks. He climbs rough walls with ease and alacrity; enters the pigeon or hen-houses, eats the eggs, pigeons, fowls, &c. and the female often kills great numbers, and transports them to her young. He likewise seizes mice, rats, moles, and birds in their nests. M. Buffon kept one of these animals for a considerable time. He tamed to a certain degree, but never formed any attachment, and continued always so wild, that it was necessary to chain him. He made war against the rats, and attacked the poultry whenever they came in his way. He often got loose, though chained by the middle of the body. At first he went to no great distance, and returned in a few hours; but without discovering any symptoms of joy, or affection to any particular person. He, however, called for victuals like a cat or a dog. Afterwards he made longer excursions; and at last he thought proper never to return. He was then about a year and a half old, seemingly the age at which nature assumes her full competency. He eat every thing presented to him, except salad and herbs; was fond of honey, and preferred hemp-seed to every other grain. It was remarked that he drank very often; that he sometimes slept two days successively, and at other times would sleep none for two or three days; that, before sleep-



Mufela.

Mufela.

ing, he folded himself in a round form, and covered his head with his tail; and that, while awake, his motions were so violent, so perpetual, and so incommodious, that, though he had not disturbed the fowls, it was necessary to chain him, to prevent him from breaking every thing. The same author informs us, that he has had in his possession several martins of a more advanced age, which had been taken in nets; but they continued to be totally savage, bit all who attempted to touch them, and would eat nothing but raw flesh.

Martins, it is said, go with young as long as cats. We meet therefore with young ones from spring to autumn; and therefore it is probable they bring forth more than once a-year. The younger females bring only three or four at a time; but the more aged produce six or seven. When about to bring forth, they take up their abode in magazines of hay, in holes of walls, which they stuff with straw and herbs; in clefts of rocks; or in the hollow trunks; and when disturbed, they remove their young, who seem very soon to arrive at maturity; for the one which M. Buffon brought up, had nearly attained its full growth in one year. The martin has an agreeable mulky odour, which proceeds from a matter contained in two vesicles, one on each side of the extremity of the rectum. The skin is a valuable fur, and much used for linings to the gowns of magistrates.

7. The putorius, pole-cat, or fitchet, has unconnected toes, is of a dirty yellow colour, with a white mouth and ears. He is a native of most parts of Europe; and has a great resemblance to the martin in temperament, manners, disposition, and figure. Like the latter, he approaches our habitations, mounts on the roofs, takes up his abode in hay-lofts, barns, and unfrequented places, from which he issues during the night only in quest of prey. He burrows under ground, forming a shallow retreat about two yards in length, generally terminating under the roots of some large tree. He makes greater havoc among the poultry than the martin, cutting off the heads of all the fowls, and then carrying them off one by one to his magazine. If, as frequently happens, he cannot carry them off entire, on account of the smallness of the entry to his hole, he eats the brains, and takes only the heads along with him. He is likewise very fond of honey, attacks the hives in winter, and forces the bees to abandon them. The females come in season in the spring; and bring forth three, four, or five at a time, but does not lead them off till the end of summer. The pole-cat is excessively fetid; yet the skin is dressed with the hair on, and used as other furs, for tippets, &c. and is also sent abroad to line cloaths. This creature seems to be confined to the temperate climates; few or none being found in the northern regions, or in the torrid zone. In Europe, his territories seem to extend only from Poland to Italy. It is certain that he avoids the cold, for in winter he retires into the houses; and he is perhaps equally averse from great heat.

8. The turo, or ferret, has red eyes, and unconnected toes; the colour of the whole body is of a very pale yellow; the length from nose to tail is about 14 inches, the tail five. In its wild state it inhabits Africa; from whence it was originally brought into Spain, in order to free that country from multitudes

of rabbits with which it was over-run; and from thence the rest of Europe was supplied with it. This creature is incapable of bearing the cold, and cannot subsist even in France unless in a domestic state. The ferret is not in our climates endowed with the same capacity of finding his subsistence as other wild animals, but must be carefully nourished within doors, and cannot exist in the fields; for those who are lost in the burrows of rabbits never multiply, but probably perish during the winter. Like other domestic animals, he varies in colour. The female ferret is less than the male; and when in season, we are assured, she is so extremely ardent, that she dies if her desires are not gratified. Ferrets are brought up in casks or boxes, where they are furnished with beds of hemp or flax. They sleep almost continually. Whenever they awake, they search eagerly for food; and brawn, bread, milk, &c. are commonly given them. They produce twice every year; and the female goes six weeks with young. Some of them devour their young as soon as they are brought forth, instantly come again in season, and have three litters, which generally consist of five or six, and sometimes of seven, eight, or nine. This animal is by nature a mortal enemy to the rabbit. Whenever a dead rabbit is for the first time presented to a young ferret, he flies upon it, and bites it with fury; but if it be alive, he seizes it by the throat or the nose, and sucks its blood. When let into the burrows of rabbits, he is muzzled, that he may not kill them in their holes, but only oblige them to come out, in order to be caught in the nets. If the ferret is let in without a muzzle, he is in danger of being lost: for, after sucking the blood of the rabbit, he falls asleep; and even smoking the hole is not a certain method of recalling him; because the holes have often several entries which communicate with each other, and the ferret retires into one of those when incommoded with the smoke. Boys likewise use the ferret for catching birds in the holes of walls, or of old trees. The ferret, tho' easily tamed, and rendered docile, is extremely irascible: his odour is always disagreeable; but when he is irritated, it becomes much more offensive. His eyes are lively, and his aspect is inflammatory; all his movements are nimble; and he is at the same time so vigorous, that he can easily master a rabbit, tho' at least four times larger than himself.

9. The zibellina, or sable, has divided toes: the body is of a dusky yellow colour, with a white forehead, and an ash-coloured throat. It is found in Tartary and the northern parts of Asia. The sables inhabit the banks of rivers, and the thickest parts of the woods. They leap with great agility from tree to tree; and avoid the rays of the sun, which are said in a short time to change the colour of their hair. They live in holes of the earth, or beneath the roots of trees: sometimes they will form nests in the trees, and skip with great agility from one to the other: they are very lively, and much in motion during the night. Mr Gmelin tells us, that after eating they generally sleep half an hour or an hour, when they may be pushed, shaken, and even pricked, without awaking. During the night they are excessively active and restless: a tame one kept by Mr Gmelin was accustomed to rise upon its hind-legs, on sight of a eat, in order to prepare for the combat. During summer,

the;

Plate  
CLXXXV.  
fig. 11.

Fig. 2.

*Muscula*. the fables prey on ermines, weasels, and squirrels, but especially on hares; in winter, on birds; in autumn, on hurtleberries, cranberries, and the berries of the service-tree: but during that season their skins are at the work; that diet causing their skins to itch, and to rub off their fur against the trees: they bring forth at the end of March or beginning of April, and have from three to five at a time, which they suckle for four or five weeks. Their chase was, in the more barbarous times of the Russian empire, the employ, or rather the task, of the unhappy exiles into Siberia: as that country is now become more populous, the fables have in great measure quitted it, and retired farther north and east, to live in desert forests and mountains: they live near the banks of rivers, or in the little islands in them: on this account they have, by some, been supposed to be the *ἄσκιος* of Aristotle, (*Hist. An. lib. viii. c. 5.*) which he classes with the animals conversant among waters.

At present the hunters of fables form themselves into troops, from 5 to 40 each: the last subdivide into lesser parties, and each chooses a leader; but there is one that directs the whole: a small covered boat is provided for each party, loaden with provisions, a dog and net for every two men, and a vessel to bake their bread in: each party also has an interpreter for the country they penetrate into: every party then sets out according to the course their chief points out: they go against the stream of the rivers, drawing their boats up, till they arrive in the hunting country; there they stop, build huts, and wait till the waters are frozen, and the season commences: before they begin the chase, their leader assembles them, they unite in a prayer to the Almighty for success, and then separate: the first fable they take is called *God's fable*, and is dedicated to the church.

They then penetrate into the woods; mark the trees as they advance, that they may know their way back; and in their hunting-quarters form huts of trees, and bank up the snow round them: near these they lay their traps; then advance farther, and lay more traps, still building new huts in every quarter, and return successively to every old one to visit the traps and take out the game to skin it, which none but the chief of the party must do: during this time they are supplied with provisions by persons who are employed to bring it on sledges, from the places on the road, where they are obliged to form magazines, by reason of the impracticability of bringing quantities through the rough country they must pass. The traps are a sort of pit-fall, with a loose board placed over it, baited with fish or flesh: when fables grow scarce, the hunters trace them in the new-fallen snow, to their holes; place their nets at the entrance; and sometimes wait, watching two or three days for the coming out of the animal: it has happened that these poor people have, by the failure of their provisions, been so pinched with hunger, that, to prevent the cravings of appetite, they have been reduced to take two thin boards, one of which they apply to the pit of the stomach, the other to the back, drawing them tight together by cords placed at the ends: such are the hardships our fel-

low-creatures undergo, to supply the wantonness of *Muscula* luxury.

The season of chase being finished, the hunters re-assemble, make a report to their leader of the number of fables each has taken; make complaints of offenders against their regulations; punish delinquents; share the booty; then continue at the head-quarters till the rivers are clear of ice; return home, and give to every church the dedicated furs.

10. The vulgaris, or founmart (A), is the least of the weasel kind; the length of the head and body not exceeding six, or at most seven inches. The tail is only two inches and an half long, and ends in a point; the ears are large; and the lower parts of them are doubled in. The whole upper part of the body, the head, tail, legs, and feet, are of a very pale tawny brown. The whole under side of the body from the chin to the tail is white; but beneath the corners of the mouth, on each jaw, is a spot of brown. It is very destructive to young birds, poultry, and young rabbits; and is besides a great devourer of eggs. It does not eat its prey on the place; but, after killing it by one bite near the head, carries it off to its young, or to its retreat. It preys also on moles, as appears by its being sometimes caught in the mole-traps. It is a remarkably active animal; and will run up the sides of walls with such ease, that scarce any place is secure from it; and the body is so small, that there is scarce any hole but what is pervious to it. This species is much more domestic than any of the rest, and frequents out-houses, barns, and granaries. It clears its haunts in a short time from mice and rats, being a much greater enemy to them than the cat itself. In summer, however, they retire farther from houses, especially into low grounds, about mills, along rivulets, concealing themselves among brush-wood, in order to surprize birds; and often take up their abode in old willows, where the female brings forth her young. She prepares for them a bed of straw, leaves, and other herbage, and litters in the spring; bringing from three to five at a time. The young are born blind; but soon acquire sight, and strength sufficient to follow their mothers. Their motion consists of unequal and precipitant leaps; and when they want to mount a tree, they make a sudden bound, by which they are at once elevated several feet high. They leap in the same manner when they attempt to seize a bird.

These creatures, as well as the pole-cat and ferret, have a disagreeable odour, which is stronger in summer than in winter; and when pursued or irritated, their smell is felt at a considerable distance. They move always with caution and silence, and never cry but when they are hurt. Their cry is sharp, rough, and very expressive of resentment. As their own odour is offensive, they seem not to be sensible of a bad smell in other bodies. M. Buffon informs us, that a peasant in his neighbourhood took three new-littered weasels out of the carcase of a wolf that had been hung up on a tree by the hind-feet. The wolf was almost entirely putrefied, and the female weasel had made a nest of leaves and herbage for her young in the thorax of this putrid carcase. The weasel may be perfectly tamed,

and

(A) This animal is confounded by Linnæus with the stoat or ermine. He seems unacquainted with our weasel in its brown colour; but describes it in its white state under the title of *Jonucus*, or *muscula nivalis*. Mr Pennant met with it in that circumstance in the Isle of Ilay.

Mutels,  
Muster.

and rendered as carefless and frolicksome as a dog or squirrel. The method of taming them is to stroke them often and gently over the back; and to threaten, and even to beat them when they bite. In the domestic state their odour is never offensive but when irritated. They are fed with milk, boiled flesh, and water.

1. The candida, stoat, or ermine, is ten inches long from the nose to the origin of the tail; the tail itself is five inches and a half long. The colours bear so near a resemblance to those of the weasel, as to cause them to be confounded together by the generality of common observers; the weasel being usually mistaken for a small stoat: but these animals have evident and invariable specific differences, by which they may be easily known. First, by the size; the weasel being ever less than the stoat: secondly, the tail of the latter is always tipped with black, is longer in proportion to the bulk of the animal, and more hairy; whereas the tail of the weasel is shorter, and of the same colour with the body: thirdly, the edges of the ears and the ends of the toes in this animal are of a yellowish white. It may be added, that the stoat haunts woods, hedges, and meadows, especially where there are brooks whose sides are covered with small bushes; and sometimes (but less frequently than the weasel) inhabits barns, and other buildings.

In the most northern parts of Europe, these animals regularly change their colour in winter; and become totally white, except the end of the tail, which continues invariably black; and in that state are called *ermine*: we are informed that the same is observed in the Highlands of Scotland. The skins and tails are a very valuable article of commerce in Norway, Lapland, Russia, and other cold countries; where they are found in prodigious numbers. They are also very common in Kamtschatka and Siberia. In Siberia they burrow in the fields, and are taken in traps baited with flesh. In Norway they are either shot with blunt arrows, or taken in traps made of two flat stones, one being propped up with a stick, to which is fastened a baited string, which when the animals nibble, the stone falls down and crushes them to death. The Laplanders take them in the same manner, only instead of stones make use of two logs of wood. The stoat is sometimes found white in Great Britain, but not frequently: and then it is called a *white weasel*. That animal is also found white; but may be easily distinguished from the other in the ermine state, by the tail, which in the weasel is of a light tawny brown. With us the former is observed to begin to change its colour from brown to white in November, and to begin to resume the brown the beginning of March.

The natural history of this creature is much the same with that of the weasel; its food being birds, rabbits, mice, &c. its agility the same, and its scent equally fetid: it is much more common in England than that animal.

MUSTER, in a military sense, a review of troops under arms, to see if they be complete and in good order; to take an account of their numbers, the condition they are in, viewing their arms and accoutrements, &c.

MUSTER-Master-general, or Commissary-general of &c. MUSTERS; one who takes account of every regi-

ment, their number, horses, arms, &c. reviews them, sees the horses be well mounted, and all the men well armed and accoutred, &c.

MUSTER-Rolls, lists of soldiers in each company, troop, or regiment, by which they are paid, and the strength of the army is known.

MUTE, in a general sense, signifies a person that cannot speak, or has not the use of speech.

MUTE, in law, a person that stands dumb or speechless, when he ought to answer, or to plead. See ARRIGNMENT.

MUTE, in grammar, a letter which yields no sound without the addition of a vowel. The simple consonants are ordinarily distinguished into mutes and liquids, or semi-vowels. See the articles CONSONANT, LIQUID, &c.

The mutes in the Greek alphabet are nine, three of which, *viz.* π, κ, τ, are termed *tenues*; three β, γ, δ, termed *medie*, and three ρ, ζ, θ, termed *aspirates*. See the article ASPIRATE, &c.

The mutes of the Latin alphabet are also nine, *viz.* B, C, D, G, I, K, P, Q, T.

MUTILATION, the retrenching or cutting away any member of the body.

This word is also extended to statues and buildings, where any part is wanting, or the projection of any member, as a cornice or an impost, is broken off. It is sometimes also used, in a more immediate manner, for CASTRATION.

MUTILLA, in zoology, a genus of animals belonging to the order of insecta hymenoptera. There are 10 species; the most remarkable of which is the *occidentalis*, or velvet-ant, an inhabitant of North America. It has six legs, with short crooked antennae; the abdomen large, with a black list crossing the lower part of it, and another black spot at the joining of the thorax; excepting which, the whole body and head resembles crimson-velvet. The trunk or shell of the body is of such a strong and hard texture, that, tho' trod upon by men and cattle, they receive no harm. They have a long sting in their tails, which causes inflammation and great pain, for half an hour, to those who are stung by them; which usually happens to negroes and others that go bare-footed. They are mostly seen running very nimbly on sandy roads in the hottest summer-weather; and always single. What they feed on, in what manner they breed, and where they secure themselves in winter, is unknown.

MUTINY, in a military sense, to rise against authority.—“Any officer or soldier who shall presume to use traitorous or disrespectful words against the sacred person of his majesty, or any of the royal family, is guilty of mutiny.

“Any officer or soldier who shall behave himself with contempt or disrespect towards the general or other commander in chief of our forces, or shall speak words tending to their hurt or dishonour, is guilty of mutiny.

“Any officer or soldier who shall begin, excite, cause, or join in, any mutiny or sedition, in the troop, company, or regiment, to which he belongs, or in any other troop or company in our service, or on any party, post, detachment, or guard, on any pretence whatsoever, is guilty of mutiny.

Muster  
Mutiny

Plate  
CLXXXVII.  
fig. 3.

Articles of  
War.

Mutius  
Muzzle.

"Any officer or soldier who, being present at any mutiny or sedition, does not use his utmost endeavours to suppress the same, or coming to the knowledge of any mutiny, or intended-mutiny, does not without delay give information to his commanding officer, is guilty of mutiny.

"Any officer or soldier, who shall strike his superior officer, or draw, or offer to draw, or shall lift up any weapon, or offer any violence against him, being in the execution of his office, on any pretence whatsoever, or shall disobey any lawful command of his superior officer, is guilty of mutiny."

MUTINY-*Act*. See MILITARY-*State*.

MUTIUS (Cains), surnamed *Codrus*, and afterwards *Scævola*, was one of the illustrious Roman family of the Mutians, and rendered his name famous in the war between Porfenna king of Tuscany and the Romans. That prince resolving to restore the family of Tarquin the Proud, went to besiege Rome 507 B. C. Mutius resolved to sacrifice himself for the safety of his country; and boldly entering the enemy's camp, killed Porfenna's secretary, whom he took for Porfenna himself. Being seized and brought before Porfenna, he told him boldly, that 300 young men like himself had sworn to murder him; but since this hand has missed thee, continued he, it must be punished; then putting his right hand on the burning coals, he let it burn with such a constancy as amazed the beholders. The king, amazed at the intrepidity of this young Roman, ordered that he should have his freedom and return to Rome, and soon after concluded a peace with the Romans. From this action Mutius obtained the surname of *Scævola*, or "left-handed," which was enjoyed by his family.

MUTIUS *Scævola* (2.), surnamed the *Augur*, was an excellent civilian, and intrusted Cicero in the laws. He was made praetor in Asia; was afterwards consul, and performed very important services for the republic.

He ought not to be confounded with Quintus Mutius Scævola, another excellent civilian, who was praetor in Asia, tribune of the people, and at length consul, 95 B. C. He governed Asia with such prudence and equity, that his example was proposed to the governors who were sent into the provinces. Cicero says, "that he was the most eloquent orator of all the civilians; and the most able civilian of all the orators." He was assassinated in the temple of Vesta, during the wars of Marius and Sylla, 82 B. C.

MUTTON, the common name of the flesh of a sheep after the animal has been killed. Mutton has been commonly preferred to all the fleshes of quadrupeds. And indeed, besides its being more perfect, it has the advantage over them of being more generally suited to different climates: whereas beef, *e. g.* requires a very nice intermediate state, which it seems to enjoy chiefly in England; for although Scotland supplies what are reckoned the best cattle, it is in the rich English pastures that they are brought to perfection. Now the sheep can be brought almost to the same perfection in this bleak northern region as in the southern countries.

MUTULE, in architecture, a kind of square modillion set under the cornice of the Doric order.

MUZZLE of a GUN or MORTAR, the extremity at

which the powder and ball is put in; and hence the muzzle-ring is the metalline circle or moulding that surrounds the mouth of the piece.

MYA, the *GAPER*, in zoology; a genus belonging to the order of vermes testacea, the characters of which are these. It has a bivalve shell gaping at one end; the hinge, for the most part, furnished with a thick, strong, and broad tooth, not inserted into the opposite valve. Its animal is an ASCIDIA. The most remarkable species are,

1. The declivis, or sloping mya, with a brittle half-transparent shell, with a hinge slightly prominent near the open, and sloping downwards. It is frequent about the Hebrides; the fish eaten by the gentry.

2. The mya pliciform, hath an oval brittle shell, with a single longitudinal tooth like a lamina in one shell, and two in the other; the breadth is a little above two inches, the length one. It inhabits rivers; the shells are used to put water-colours in, whence the name. Otters feed on this and the other fresh-water shells.

3. The margaritifera, or pearl mya, hath a very thick, coarse, opaque shell; often much decorticated; oblong, bending inward on one side; or arcuated; black on the outside; usual breadth from five to six inches, length two and a quarter. It inhabits great rivers, especially those which water the mountainous parts of Great Britain. See Plate CLXXVI. fig. t8.

This shell is noted for producing quantities of pearl. There have been regular fisheries for the sake of this precious article in several of our rivers. Sixteen have been found within one shell. They are the disease of the fish, analogous to the stone in the human body. On being squeezed, they will eject the pearl, and often cast it spontaneously in the sand of the stream. The Conway was noted for them in the days of Cambden. A notion also prevails, that Sir Richard Wynne of Gwydir, chamberlain to Catharine queen to Charles II. presented her majesty with a pearl (taken in this river) which is to this day honoured with a place in the regal crown. They are called by the Welsh *oregin diluw*, or "deluge shells," as if left there by the flood. The Irt in Cumberland was also productive of them. The famous circumnavigator, Sir John Hawkins, had a patent for fishing in that river. He had observed pearls plentiful in the Straits of Magellan, and flattered himself with being enriched by procuring them within his own island. In the last century, several of great size were gotten in the rivers of the counties of Tyrone and Donegal in Ireland. One that weighed 36 carats was valued at 40l.; but being foul, lost much of its worth. Other single pearls were sold for 4l. 10s. and even for 10l. The last was sold a second time to Lady Gleghley, who put it into a necklace, and refused 80l. for it from the dukes of Ormond.

Suetonius reports, that Cæsar was induced to undertake his British expedition for the sake of our pearls; and that they were so large that it was necessary to use the hand to try the weight of a single one. Mr Pennant supposes that Cæsar only heard this by report; and that the crystalline balls called *mineral pearls*, were mistaken for them.

Mys.

Plate  
CLXXVI.

Myagrūm  
Mygdonia.

We believe that Cæsar was disappointed of his hope: yet we are told that he brought home a buckler made with British pearl, which he dedicated to, and hung up in, the temple of Venus Genetrix: a proper offering to the goddess of beauty, who sprung from the sea. It may not be improper to mention, that notwithstanding the classics honour our pearl with their notice, yet they report them to have been small and ill-coloured, an imputation that in general they are still liable to. Pliny says, that a red small kind was found about the Thracian Bosphorus, in a shell called *mya*; but does not give it any mark to ascertain the species.

**MYAGRUM**, *GOLD OF PLEASURE*; a genus of the filiculosa order, belonging to the tetradyminaea class of plants. There are five species; but the only remarkable one is the fatiug, which grows naturally in corn-fields in the south of France and Italy, and also in some parts of Britain. It is an annual plant, with an upright stalk a foot and an half high, sending out two or four side-branches, which grow erect; the flowers grow in loose spikes at the end of the branches, standing upon short footstalks an inch long: they are composed of four small yellowish petals, placed in form of a cross; these are succeeded by oval capsules, which are bordered and crowned at the top with the style of the flower, having two cells filled with red seeds. This is cultivated in Germany for the sake of the expressed oil of the seeds, which the inhabitants use for medicinal, culinary, and oeconomic purposes. The seeds are a favourite food with geese. Horses, goats, sheep, and cows, eat the plant.

**MYCENE**, (Homer); a town of Argolis; formerly the capital, and the royal residence of Agamemnon, fifty stadia to the north of Argos, celebrated by the poets. After the war of Troy, on the extinction of Agamemnon's kingdom, it fell to such decay, that in Strabo's time there was not so much as a trace of it remaining: but that, in the Macedonian war carried on by the Romans, there was something of a town, is plain from the *Excerpta* of Polybius, to whom add Livy. It was famous for its breed of horses. (Virgil, *Horace*).

**MYCONE**, an island of the Archipelago, situated in E. Long. 25. 51. N. Lat. 37. 28. It is about 36 miles in circuit; and has a town of the same name, containing about 3000 inhabitants. The people of this island are said to be the best sailors in the Archipelago, and have about 150 vessels of different sizes. The island yields a sufficient quantity of barley for the inhabitants, and produces abundance of figs, and some olives; but there is a scarcity of water, especially in summer, there being but one well on the island. There are a great number of churches and chapels, with some monasteries. The drefs of the women in this island is very remarkable, and as different from that of the other islands as that of those islands is different from the drefs of the other European ladies. Their heads are adorned with lively-coloured turbans; their garments are a short white shift plaited before and behind, which reaches to their knees; they have white linen-drawers, and red, green, yellow, or blue stockings, with various coloured slippers. An ordinary suit for the better sort will cost 200 crowns.

**MYGDONIA**, (anc. geog.) a district of Macedonia, Vol. VII.

to the north of the Sinus Thernaicus, and east of the river Axius, which separates it from Bottiæ, and west of the river Strymon, (Pliny). Also a district of Mesopotamia, which took its name from that of Macedonia, running along the Euphrates, from Zeugma down to Thapaciæ; extending a great way east, because Nisibis was reckoned to it.

**MYOLOGLOSSUM**, in anatomy. See *ANATOMY*, *Table of the Muscles*.

**MYLOHYOIDÆUS**. *Ibid*.

**MYOPIA**, *SHORT-SIGHTEDNESS*, a species of vision wherein objects are seen only at small distances. See *MEDICINE*, n<sup>o</sup> 178.

**MYOSOTIS**, *SCORPION-GRASS*; a genus of the monogynia order, belonging to the pentandria class of plants. There are four species; of which the most remarkable is the scorpioides, or mouse-ear. This is a native of Britain, growing naturally in dry fields, and on the margins of springs and rills. It hath naked seeds, and the points of the leaves callous. It varies considerably in different situations. In dry places the plant and flowers are smaller; in moist ones both are larger, and sometimes hairy. The blossoms vary from a full blue to a very pale one, and sometimes a yellow; and appear in a long spirally twisted spike. When it grows in the water, and its taste and smell is thereby rendered less observable, sheep will sometimes eat it; but it is generally fatal to them. Cows, horses, swine, and goats, refuse it.

**MYRIAD**, a term sometimes used to denote ten thousand.

**MYRICA**, *GALE*, or *SWEET-WILLOW*, in botany; a genus of the tetrandria order, belonging to the diœcia class of plants.

*Species*. 1. The gale, or sweet-willow, grows naturally in many places both of Scotland and England. It rises near four feet high, with many shrubby stalks, which divide into several slender branches, garnished with stiff spear-shaped leaves of a light yellowish green, smooth, and a little sawed at their points; and emit a fragrant odour when bruised. The female flowers or catkins are produced from the sides of the branches, growing upon separate plants from the female, which are succeeded by clusters of small berries, each having a single seed. It flowers in July, and ripens in autumn. 2. The cerifera, or candleberry gale, is a native of North America. It is a small tree or shrub about twelve feet high, with crooked stems branching forth near the ground irregularly. The leaves are long, narrow, and sharp-pointed. Some trees have most of their leaves serrated, others not. In May, the small branches are alternately and thick set with oblong tufts of very small flowers, resembling in form and size the catkins of the hazel-tree, coloured with red and green. These are succeeded by small clusters of blue berries close connected, like bunches of grapes. The kernel is inclosed in an oblong, hard stone, incrustured over with an unctuous mealy substance, from which the wax is procured in the following manner: in November and December, when the berries are ripe, a man with his family will remove from home to some island or sand-bank near the sea, where these trees most abound, taking with them kettles to boil the berries in. He builds a hut with palmetto-leaves for the shelter of himself

Myloglossum  
Myrica.

Myrmeco-  
phaga.

himself and family during his residence there, which is commonly for four or five weeks. The man cuts down the trees, while the children strip off the berries into a porridge-pot; and having put water to them, they boil them till the oil floats, which is then skimmed off into another vessel. This is repeated till no more oil appears. When cold, this hardens to the consistence of wax, and is of a dirty green colour. Then they boil it again, and clarify it in brass kettles; which gives it a transparent greenness. These candles burn a long time, and yield a grateful smell. They usually add a fourth part of tallow, which makes them burn clearer.

MYRMECOPHAGA, or ANT-BEAR, in zoology; a genus of quadrupeds, belonging to the order of bruta; the characters of which are these: There are no teeth in the mouth; the tongue is long and cylindrical: the head terminates in a long snout or muzzle; and the body is covered with pretty long hair. There are four species, viz.

Plate  
CLXXXV.

1. The didaſyla, or little ant-eater, hath a conic nose bending a little down; ears small, and hid in the fur; two hooked claws on the fore-feet, the exterior being much the largest; four on the hind-feet; the head, body, limbs, and upper part and sides of the tail, covered with long soft silky hair, or rather wool, of a yellowish brown colour: from the nose to the tail it measures seven inches and an half; the tail eight and an half; the last four inches of which on the under side are naked. It is thick at the base, and tapers to a point. It inhabits Guinea, climbs trees in quest of a species of ants which build their nests among the branches: has a prehensile power with its tail.

2. The tridactyla, tamandu-guaca, or tamanoir, has three toes on the fore-feet, five on the hind-feet, and long hair on the tail. This animal is about four feet long, and the head and snout about 15 inches: it is a native of the East Indies, and feeds on ants, &c. in the same manner as the former.

3. The jubata, or great ant-eater, hath a long slender nose, small black eyes; short round ears; a slender tongue two feet and an half long, which lies double in the mouth; the legs slender; four toes on the fore-feet, five on the hind-feet; the two middle claws on the fore-feet very large, strong, and hooked; the hair on the upper part of the body is half a foot long, black mixed with grey; the fore-legs are whitish, marked above the feet with a black spot; the tail is clothed with very coarse black hair a foot long: the length from the nose to the tail about four feet; the tail, two feet and an half.

4. The tetradaſyla, or middle ant-eater, has four toes on the fore-feet, and five on the hind, with a tail naked at the extremity; the length from the nose to the tail is one foot seven inches, and the tail ten inches.

These animals have many properties in common with each other, both in their structure and manners. They all feed upon ants, and plunge their tongues into honey and other liquid or viscid substances. They readily pick up crumbs of bread, or small morsels of flesh. They are easily tamed, and can subsist for a long time without food. They never swallow all the liquor which they take for drink; for a part of it falls

back through their nostrils. They run so slowly that a man may easily overtake them in an open field. Their flesh, though its taste be very disagreeable, is eaten by the savages.—At a distance the great ant-eater has the appearance of a fox; and for this reason some travellers have given him the name of the *American fox*. He has strength sufficient to defend himself from a large dog, or even from the jaguar or Brazilian cat. When attacked, he at first fights on end, and, like the bear, annoys his enemy with the claws of his fore-feet, which are very terrible weapons. He then lies down on his back, and uses all the four feet; in which situation he is almost invincible; and continues the combat to the last extremity. Even when he kills his enemy, he quits him not for a long time after. He is enabled to resist better than most other animals; because he is covered with long bushy hair; his skin is remarkably thick; his flesh has little sensatious; and his principle of life is very tenacious.

MYRMIDONS, MYRMIDONES, in antiquity; a people of Thessaly, fabled to have arose from ants or pismires, upon a prayer put up for that purpose by king Æacus to Jupiter, after his kingdom had been dispeopled by a severe pestilence.—In Homer and Virgil, the Myrmidons are Achilles's soldiers.

MYROBALANS, a kind of medicinal fruit brought from the Indies, of which there are five kinds. 1. The citrine, of a yellowish red colour, hard, oblong, and the size of an olive. 2. The black, or Indian myrobalan, of the bigness of an acorn, wrinkled, and without a stone. 3. Chebuleic myrobalans, which are of the size of a date, pointed at the end, and of a yellowish brown. 4. Emblic, which are round, rough, the size of a gall, and of a dark brown. 5. Balleric, which are hard, round, of the size of an ordinary prune, less angular than the rest, and yellow. They are all slightly purgative and astringent. The word comes from the Greek *μυροβαλον*, "ointment," and *βαλεω*, "acorn;" as being in the form of acorns, and used in medicine.

MYRON, an excellent Grecian statuary, flourished 442 B. C. The cow he represented in brass was an admirable piece of workmanship, and was the occasion of many fine epigrams in Greek.

MYRRH, in the materia medica, a concrete, gummy, resinous juice, brought from the East Indies in globes or drops, of various colours and magnitudes. The best sort is of a brown reddish or yellow colour, somewhat transparent; of a lightly pungent bitter taste, with an aromatic flavour, though not sufficient to prevent its proving nauseous to the palate; and a strong disagreeable smell. The medical effects of this aromatic bitter are, to warm and strengthen the viscera, and dissolve thick tenacious juices: it frequently occasions a mild diaphoresis, and promotes the fluid secretions in general. Hence it proves serviceable in languid cases; diseases arising from a simple inactivity; those female disorders which proceed from a cold, mucous, sluggish indispotion of the humours; suppressions of the uterine discharges; cachectic disorders, where the lungs and thorax are oppressed by viscid phlegm. Myrrh is likewise supposed in a peculiar manner to resist putrefaction in all parts of the body; and in this light stands recommended in malignant, putrid, and pletisical fevers, and in the small  
pox;

Myrmidons

Myrrh.

Myrtiform, pox; in which last it is said to accelerate the eruption.—  
 Myrtus. Rectified spirit extracts the fine aromatic flavour and

bitterness of this drug, and does not elevate any kind of either in evaporation: the gummy substance left by this menstrum has a disagreeable taste, with scarce any thing of the peculiar flavour of the myrrh; and dissolves in water, excepting some impurities which remain. In distillation with water, a considerable quantity of a ponderous essential oil arises, resembling in flavour the original drug.

MYRTIFORM, in anatomy, an appellation given to several parts, from their resembling myrtle-berries.

MYRTLE, in botany. See MYRTUS.

MYRTUS, in botany, the MYRTLE; a genus of the monogynia order, belonging to the icofandria class of plants. The most remarkable species are, 1. The communis, or common myrtle-tree, rises with a shrubby, upright, firm stem, branching numerously all around into a close full head, rising eight or ten feet high; very closely garnished with oval-lanceolate, entire, mostly opposite leaves, from half an inch to an inch and a half long, and one broad, on short footstalks; and numerous, small, pale flowers from the axillæ, singly on each footstalk, having diphyllous involucrem; each flower succeeded by a small, oval, dark-purple berry.

The most material varieties are, Broad-leaved Roman myrtle, with oval, shining, green leaves, an inch and an half long, and one broad; and is remarkably floriferous. Gold-striped broad-leaved Roman myrtle. Broad-leaved Dutch myrtle, with spear-shaped, sharp-pointed, dark-green leaves, an inch long, and about three quarters of one broad. Double flowered Dutch myrtle. Broad-leaved Jews myrtle, having the leaves placed by threes at each joint; by which particular circumstance this species is in universal estimation among the Jews in their religious ceremonies, particularly in decorating their tabernacles; and for which purpose many gardeners about London cultivate this variety with particular care, to sell to the above people, who are often obliged to purchase it at the rate of sixpence or a shilling for a small branch: for the true sort, having the leaves exactly by threes, is very scarce, and is a curiosity; but by care in its propagation, taking only the perfectly ternate-leaved shoots for cuttings, it may be increased fast enough; and is worth the attention of the curious, and particularly those who raise myrtles for the London markets. Orange-leaved Spanish myrtle, with oval spear-shaped leaves, an inch and a half long or more, and one broad, in clusters round the branches, and resemble the shape and colour of orange-tree leaves. Gold-striped-leaved orange myrtle. Common upright Italian myrtle, with its branches and leaves growing more erect, the leaves oval, lanceolate-shaped, acute-pointed, and near an inch long, and half a one broad. Silver-striped upright Italian myrtle. White-berried upright Italian myrtle. Portugal acute-leaved myrtle, with spear-shaped, oval, acute-pointed leaves, about an inch long. Box-leaved myrtle, with weak branches, small, oval, obtuse, lucid-green, closely-placed leaves. Striped box-leaved myrtle. Rosemary leaved myrtle, hath erect branches, small, narrow, lanceolate, acute-pointed, shining, green, very fragrant leaves. Silver-striped rosemary-leaved myrtle. Thyme-leaved

myrtle, with very small closely-placed leaves. Nutmeg-myrtle, with erect branches and leaves; the leaves oval, acute-pointed, and finely scented like a nutmeg. Broad-leaved nutmeg-myrtle. Silver-striped leaved ditto. Criflated or cock's comb myrtle, frequently called *bird's-nest myrtle*, hath narrow, sharp-pointed leaves, criflated at intervals.

These are the principal varieties of the *myrtus communis*; but of which sorts there are several intermediate varieties of less note; and more may still be obtained from seed, though the plants are rarely raised from seed in this country, but mostly by slips and cuttings.

They are all beautiful ever-green shrubs of exceeding fragrance; exotics originally of the southern parts of Europe, and of Asia and Africa, and consequently in this country require shelter of a green-house in winter: all of which, though rather of the small-leaved kind, have their foliage closely placed, and remain all the year, and are very floriferous in summer; and when there is a collection of the different sorts, they afford an agreeable source of variety with each other. They therefore claim universal esteem as principal green-house plants, especially as they are all so easily raised from cuttings, and of such easy culture as to be attainable in every garden, where there is any sort of green-house, or garden-frames furnished with glasses for protecting them in winter from frost: but some of the broad-leaved sorts are so hardy as to succeed in the full ground, against a south wall and other warm exposures, all the year, by only allowing them shelter of mats occasionally in severe frosty weather: so that a few of these sorts may also be exhibited in a warm situation in the shrubbery: observing, however, all the sorts are principally to be considered as green-house plants, and a due portion of them must always remain in pots to move to that department in winter.

*Stove-kinds.*—There are several species of the stove-temperature, as being natives of the Indies: but there are not more than the four following sorts commonly met with in the British gardens, all of which are beautiful ever-greens, with larger leaves than the *myrtus communis*; and are mostly from aromatics.

2. The zelanica, or Ceylon white-berried myrtle, hath a shrubby upright stem, branching erectly six or eight feet high; oval, shining-green, opposite, very odoriferous leaves, on short footstalks; and all the branches terminated by pedunculi, each sustaining many flowers; succeeded by snowy-white berries, but rarely in Britain.

3. The pimenta, pimento, or Jamaica all-spice-tree, rises with an upright tree-stem, branching regularly 20 or 30 feet high, having a smooth brown bark; large, oblong-oval, stiff, shining, very odoriferous leaves, like those of bay, placed alternate; and at the sides and termination of the branches large loose bunches of greenish flowers; succeeded by round, dusky, hard, spicy fruit, called *all-spice*, or *Jamaica-pepper*.—This species is an excellent aromatic; its leaves are remarkably fine-scented; and its fruit is that valuable spice, Jamaica pepper, or all-spice, so called, because it is supposed to partake of the odour and taste of most other spices. The tree grows in great abundance in the island of Jamaica, where its fruit is made a considerable branch of trade. It is generally gathered a little

Myrtus.

before it acquires full growth, and dried in the sun 10 or 12 days; is then packed up ready for exportation to Europe.

4. The dioica, or dioecious American myrtle, rises with an upright tree-stem, branching many feet high; oblong, thick, opposite, odoriferous leaves; and at the axillæ and ends of the branches pedunculi dividing into trichotomous panicles of dioecious flowers; succeeded by small, globular, spicy berries. Every part of the tree is a strong aromatic.

5. The brasiliæna, or Brasilian inodorus myrtle, rises with a branching stem, having a whitish bark: broad, oval, shining, opposite, inodorous or scentless leaves, and naked pedunculi, sustaining solitary flowers, with ciliated petals; succeeded by large oval fruit.

All these five species of myrtus are exotics of the shrub and tree kind; though in this country, as being confined in pots, the largest of them assume only the growth of moderate shrubs. The first species, common myrtle, is considerably the most noted species of this genus in this country; where in most of our greenhouse collections one or other of the varieties is found in tolerable plenty; but all the varieties of it highly merit notice. The other four species are rare in Britain: they, however, are retained in many curious gardens, in the stove-collection; more particularly the pimento, which is a very beautiful odoriferous evergreen, and exhibits a fine variety in the stove at all seasons. In short, all the species, both greenhouse and stove-kinds, have a pretty effect as ever-greens; and some of the sorts flower very ornamentally, particularly of the common myrtle.

With respect to flowering, all the varieties of the *myrtus communis* flower here in July and August, most of which are very floriferous: the broad-leaved Roman kind, in particular, is often covered with flowers, which in some of the sorts are succeeded here by berries ripening in winter. Some of the stove kinds also flower here, but are rarely succeeded by fruit in England.

The flowers, however, of most of the sorts are small, but numerous; and are all formed each of five oval petals, and many lamina.

As all the species require occasional shelter here, they must be kept always in pots, for moving to the proper places of shelter, according to their nature; the *myrtus communis* and varieties to the greenhouse in winter; the others to the stove, to remain all the year: therefore let all the sorts be potted in light rich earth, and, as they advance in growth, shift them into larger pots, managing the myrtles as other greenhouse shrubs, and the stove-kinds as other woody exotics of the stove.

But, as we before observed, the broad-leaved *myrtus communis*, being harder than the smaller-leaved kinds, some of them may also be turned out into the full ground in a warm situation against a wall, &c. allowing them shelter of mats in frosty weather, and mulch the ground over their roots: they will frequently succeed tolerably, and effect a good variety in such places. They may all be propagated by slips, cuttings, or layers.

The leaves and flowers of common upright myrtle have an astringent quality, and are used for cleansing the skin, and strengthening the fibres. From the flowers and young tops is drawn a distilled water that is

deterfive, astringent, cosmetic, and used in gargles. A decoction of the flowers and leaves is applied in fomentations. The berries have a binding deterfive quality; and the chemical oil obtained from them is excellent for the hair, and used in pomatums and most other external beautifiers of the face and skin. As an internal medicine, these berries have little or no merit.

MYSIA, (anc. geog.), a country of the Hither Asia, which Strabo makes two-fold; the one called *Olympena*, near mount Olympus, whence its name; the other near the river Caicus and Pergamene, as far as Teuthrania, and down to the mouth of the Caicus; a part of which was afterwards called *Æolis*, from the Eolians, (Mela, Pliny); by which means this Mysia was greatly contracted in its limits.—There were also two other Myrias, called *Abrettene* and *Morrene*; which see. Strabo mentions a small district, called *Mysia Combusta*, famous for generous wines; which, whether to be allotted to *Mysia* or *Lydia*, he is doubtful: it was in length 500 stadia, in breadth 400: and he observes, that it is a matter of difficulty to settle the limits of the Bithynians, Myrians, Phrygians, Mygdonians, and Trojans, being so intermixed and blended; which gave rise to a proverb, denoting the difficulty of distinguishing things, though really distinct. *Mysi*, or *Mysi*, the people, were held in the utmost contempt; so that *Mysorum ultimus* denotes a person highly despicable, (Cicero): and because the being made a property of is generally the consequence of contempt, this gave rise to another proverb, *Μυσίου λαός*, (Aristotle). The name *Mysie* is said to denote the beech-tree, which grows plentifully about Olympus; and hence the country took its name.

MYSTERY, something secret or concealed, impossible or difficult to comprehend.

All religions, true or false, have their mysteries. The pagan religion was remarkably full of them. Ovid reckons it a great crime to divulge the mythic rites of Ceres and Juno. The eleusinia, or sacred rites of Ceres, solemnized at Eleusis, were called, by way of eminence, *the mysteries*; and so superstitiously careful were they to conceal these sacred rites, that if any person divulged any part of them, he was thought to have called down some divine judgment on his head, and it was accounted unsafe to abide under the same roof with him; and Horace declares, that he would not put to sea in the same ship with one who revealed the mysteries of Ceres. The pagan mysteries, it is true, were generally mysteries of iniquity, and concealed only because their being published would have rendered their religion ridiculous and odious. Thus the sacred writings often speak of the infamous mysteries of the pagan deities, in which the most shameful crimes were committed under the specious veil of religion.

The whole religion of the Egyptians was mysterious from the beginning to the end, and both their doctrine and worship wrapped up in symbols and hieroglyphics.

The religion of the Jews is supposed to be full of mysteries. The whole nation, according to St Augustin, was a mystery, as it represented or was a type of the people of Christ, and the Christian religion. Whatever was commanded or forbidden them was figurative;

Myfia,  
Myftery.



gurative; and their sacrifices, priesthood, &c. included mysteries. The prophecies concerning Jesus Christ in the Jewish books, are likewise figurative and mysterious.

The Christian religion has also its mysteries: but in the scripture-language the word *mystery* is used with some latitude, and denotes whatever is not to be known without a divine revelation, and all the secret things which God has discovered by his ministers the prophets, by Jesus Christ and his apostles. The mysteries of the Christian church are, The incarnation of the Word; the hypostatical union of the divine and human natures; the miraculous birth, death, and resurrection of the Son of God; and the doctrine of the Trinity, &c.

St Paul often speaks of the mysteries of the Christian religion; as the mystery of the gospel, the mystery of the cross of Christ, the mystery which was kept secret since the world began: and he calls the preachers of the gospel, the stewards of the mysteries of God.

MYSTICAL, something mysterious or allegorical. Some of the commentators on the sacred writings, besides a literal, find also a mystical meaning. The sense of scripture, say they, is either that immediately signified by the words and expressions in the common use of language; or it is mediate, sublime, typical, and mystical. The literal sense they again divide into proper literal, which is contained in the words taken simply and properly; and metaphorical literal, where the words are to be taken in a figurative and metaphorical sense. The mystical sense of scripture they divide into three kinds: the first corresponding to faith, and called *allegorical*; the second to hope, called *anagogical*; and the third to charity, called the *tropological sense*. And sometimes they take the same word in scripture in all the four senses: thus the word *Jerusalem*, literally signifies the capital of Judæa; allegorically, the church militant; tropologically, a believer; and anagogically, heaven. So that passage in Genesis, *let there be light, and there was light*, literally signifies corporeal light; by an allegory, the Messiah; in the tropological sense, grace; and anagogically, beatitude, or the light of glory.

MYSTICS, a religious sect, distinguished by their professing a pure, sublime, and perfect devotion, with an entire disinterested love of God, free from all selfish considerations, and by their aspiring to a state of passive contemplation.

MYTHOLOGY. The word *mythology* is a Greek compound, that signifies a *discourse on fables*; and comprehends, in a collective sense, all the fabulous and poetic history of pagan antiquity. It follows therefore, that this science teaches the history of the gods, demi-gods, and fabulous heroes of antiquity; the theology of the pagans, the principles of their religion, their mysteries, metamorphoses, oracles, &c. By this definition, it appears sufficiently what are the objects of which we are to treat in this article.

If we well consider the matter, we shall find, that there were, in pagan antiquity, three different religions. *First*, That of the philosophers, who treated metaphysically of the nature, the attributes, and of the works of the Supreme Being. They endeavoured to discover the true God, and the manner in which he ought to be worshipped. It is not wonderful, that

these men of exalted genius should in some degree ridicule, in their works, the two other positive religions, and those gods on whom they were founded; at the same time that they outwardly professed the established religion, in order to preserve the peace of society, and to avoid the persecutions of the legislature, and the insults of the populace. For in fact, was it possible for them to believe the pagan fables? Must they not foresee, that their religion would one day give place to another, while their own works would pass with their names to the latest posterity? And could they suffer the thought, that their reputation would be tarnished in the eyes of that posterity, by having it imagined they believed such idle tales as were broached by the priests of their times? Could Plato, Socrates, Seneca, and Cicero, be unconcerned for their fame among future generations and future philosophers? And what should we at this day have said of those great men, had they been so political, or hypocritical, as to have entirely concealed their sentiments with regard to these matters?

The second religion was that of paganism, which was the established religion of all the ancient nations except the Jews. This was the doctrine that was taught by the priests, and protected by the sovereigns. Its dogmas were demonstratively false, but not always so absurd as may at first appear; especially if we annex to the divinities, and to the religious ceremonies of the pagans, a sense that is frequently mystic, and always allegoric; if we remember, that the first heathens deified those great men to whom the rest of mankind were indebted for any signal benefits, as Jupiter, Apollo, Ceres, Bacchus, Hercules, Æsculapius, &c. in order to induce others, as well of the present as future ages, to reverence and to imitate them. Would not an ancient pagan, if he were to return upon the earth, have specious arguments, at least, to support his religion, when he saw weak mortals beatify or canonize, merely by their own authority, other weak mortals (frequently mere pedants), and place them in heaven, without the permission or approbation of the Supreme Being? Happy is it for mankind, when at different times sagacious pontiffs purge the calendar, and the brains of the people, from a herd of pretended saints, and prevent them, at least after their death, from doing injury to society, by interrupting the industry of the laborious inhabitants with keeping their festivals.

The third religion was idolatry, or the religion of the populace. For the common people, born to be deceived in every thing, confounding in their imaginations the statues of the gods, the idols of their divinities, the emblems of their virtues and of religious worship, with the gods, divinities, virtues, and worship themselves, adored these images, and proceeded to extravagancies the most ridiculous, and frequently most criminal, in their ceremonies, feasts, libations, sacrifices, &c. It is to be feared, that, as long as there are upon the earth men of our limited capacities, this triple religion will constantly subsist under different forms; and we are much deceived, if it may not be found under the empire of Christianity itself, notwithstanding the purity of its doctrine. It will be easily conceived, that it is not of the religion of philosophers, nor that of the populace, of which we are to treat in this article of *Mythology*: but of that which

subsisted

Mythology. subsisted under the authority of the magistracy and the priesthood, and consequently of paganism in general.

As far as we are able to judge by all the ancient authors we have read, the pagans adored the sovereign Lord of the universe under the name of *Fate* or *Destiny*, which we must not confound with *Fortune*, who was regarded as a subaltern divinity. Jupiter himself, all the gods, every animated being, the heavens, the earth, the whole frame of nature, was subservient to *Destiny*, and nothing could reverse its decrees. This divinity was so highly adorable, as to be above all rank; and was regarded as too supreme to be represented under any sensible image or statue, or to have any temple erected for its worship. We do not remember to have read, that ever any sacrifice was offered to this *Destiny*, or that any temple or city was ever dedicated to its name. We are almost inclined to think, that the pagans were sensible, that the temple and the worship of the God of gods ought to be in the heart of man. Mention is made, indeed, of a temple that was dedicated to the Unknown God; but we are ignorant whether or not *Destiny* were thereby meant. We must not confound this *Destiny*, moreover, with the goddesses of chance, of which there are some antique statues that represent her in a recumbent posture, and playing with little bones; for this was nothing more than an invention of some statuary.

After this general and philosophical idea of the Supreme Being, comes the positive religion of the pagans. This was entirely founded on fable, which took its rise either from ancient traditions, or historical events, altered or augmented by the imaginations of the poets, by superstition, or by the credulity of the people; or else it consisted of allegoric or moral fictions. A crowd of writers, and among the rest *Noël le Comte*, (*Natalis Comes*), the abbots *Bannier* and *Pluche*, &c. have made many researches into the origin of fable: and they think they have discovered its source, 1. In the vanity of mankind; 2. In the want of letters and characters; 3. In the delusive eloquence of orators; 4. In the relations of travellers; 5. In the fictions of poets, painters, statuary, and dramatic writers; 6. In the diversity and uniformity of names; 7. In the ignorance of true philosophy; 8. In the foundation of colonies, and the invention of arts; 9. In the desire of having gods for our ancestors; 10. In the imperfect or false interpretation of the holy scriptures; 11. In the ignorance of ancient history; 12. In a like ignorance of chronology; 13. In that of foreign languages; 14. In the translation of the religion of the Egyptians and Phœnicians into Greece; 15. In the ignorance of geography; and, 16. In the belief which the first people had of the intercourse of gods with men. It is certain, that all these matters taken together are sufficient to produce many thousands of fables; are more than sufficient to enable us to deceive ourselves and others, and to give rise to infinite reveries. But we should take care how we draw from these sources demonstrations that might be used, by infidels, as arguments to overthrow the history of the Jews; a people the most stupid, most credulous, and ostentatious of all others. In the mean time, the pagan philosophers themselves asserted, that it was a god who invented the fable: so much they were convinced of its ingenuity, and of its strong tendency to instruct man-

kind in their duty.

Mythology therefore, when properly treated, begins with making learned researches into the real origin of fable, of paganism, and of that idolatry which was its consequence. It recurs for this purpose even to the beginning of the world: and after finding that *Laban*, the father-in-law of the patriarch *Jacob*, was a maker of idols, and that he had his little images, or household gods, which he formed of baked earth, and which shews that idolatry existed in the greatest antiquity; it then explains cosmogony, and theogony, or the belief that the first inhabitants of the earth entertained of the creation of the universe, and what the pagan theology taught of the genealogy of their false gods. It begins with the tradition of the Chaldeans, a people so ancient, that *Nimrod* was their first king; but at the same time so credulous and superstitious, that we may regard them as the authors of all those fables, and the propagators of all those visions, that have since blinded human reason. According to this tradition, a monster named *Oannes*, or *Oes*, half fish and half man, sprang from the sea, before the chaos was completely dispersed, and gave laws to the Chaldeans. A woman called *Omyka*, reigned over all the earth. *Bet cut* her in two, and made of one moiety the heavens, and of the other the earth. They likewise invented the two primitive beings; of which the good one, who was named *Orasmasdes*, had the direction of heaven; and the other, called *Armanius*, that of hell.

The science of mythology then teaches the theogony of the Phœnicians; concerning whom it draws great lights from *Sanchoniathon*, a priest of *Beryte*, who lived before the Trojan wars, more than 400 years before *Hesiod* and *Homer*, and of whom *Eusebius* has preserved considerable fragments. From thence it passes to the theogony of the Egyptians; of whom *Thot* or *Thaut*, the founder of that nation, was likewise, they say, their first historian; that *Sanchoniathon* even copied from him; and of whom we find many relations in the Greek historians, especially in *Herodotus*, *Diodorus Siculus*, and in *Eusebius* of *Cæsarea*. It then examines the theogony of the Atlantes, who dwelt on the western part of *Africa*, and of whom *Diodorus* alone has preserved any account. From thence it proceeds to the theogony of the Greeks, which is far better known to us, as we find accounts of it, more or less particular, in numberless Greek and Latin writers. This theogony had the same foundation as that of the Romans; the latter having only extended it, by adding to the Greek divinities certain gods or demigods, formed of their heroes, and certain symbolic and allegoric divinities, which mythology explains at the same time: and it is on this occasion that it enters into a particular explication of the cosmogony and theogony of *Ovid*; whose book of *metamorphoses* contains as copious descriptions as we could desire of the fables of the ancients: what was their belief concerning the habitations of the blessed after their death, or of the *Elysian fields*; as well as of their hell or *Tartarus*; of the dog *Cerberus*, of the ferryman *Charon*; of the furies; of the four rivers, *Cocytus*, *Lethæ*, *Phlegethon*, and *Styx*, which water the *Tartarian* regions, &c.

Mythologists then continue their researches into the time, the epoch, and place, of the real origin of paganism and idolatry; and they prove that the pagans began

Mythology began by adoring the heavenly bodies, the stars and planets. They next examine into the progress of idolatry: what were the temples of the pagans, their altars, their inclosures, their sacred groves, their asylums, the idols and statues of their deities; in what manner they were represented; what were their sacrifices, the victims that were offered; what the days of penitence and supplication, the feasts or the gods of lechisternia, their invocations or incantations and exorcisms, the religious ceremonies observed at laying the foundations of cities, &c.

Divination, or the prediction of future events, a weakness that has at all times possessed the human mind, forms also an important article of pagan theology. It is therefore in this place that mythology considers the nature of oracles, and in what manner these oracles gave their answers; the ceremonies that were observed in consulting them; the frantic emotions of the priestess Pythia on her tripod, and those of other priests. See DIVINATION and ORACLES.—It then endeavours to investigate the history of the Sibyls, and of their prophecies. See SIBYLS.—It next passes to the examen of the nature of auguries, auspices, haruspices, prodigies, &c.; of expiations and ablutions; of the magic and astrology of the ancients, &c. See AUGURY, &c.—It then proceeds to the examination of the nature of the pagan divinities themselves.

The celebrated treatise of Cicero *De natura Deorum*, will here furnish great lights: but modern authors who have treated on these matters, have not been contented with this alone: they have, so to say, extracted the essence of all antiquity, of which they have formed systems; but unluckily these scarce ever agree with each other. As philosophers, it is of very little importance for us to know what was the nature of these gods, seeing we know that they were merely fabulous: but as historians and antiquaries, it concerns us to know what was the nature that was attributed to them in general; and, in particular, what were the origin, genealogy, rank, functions, authority, and operations, that were attributed to each divinity; and it is on these matters that we have still some remarks to make.

The gods of the ancient Greeks and Romans were all either *Dii majorum gentium*, or *Dii minorum gentium*; that is, of the first or second order. The former were also called *consentes*, *magni consultores*, &c. According to Ennius, they were 12 in number, and are included in these verses:

Juno, Vesta, Minerva, Ceres, Diana, Venus, Mars,  
Mercurius, Jovis, Neptunus, Vulcanus, Apollo.

To these were added eight others, under the title of *Selecti*, which were Sol, Luna, Tellus, Genius, Janus, Saturnus, Liber, and Pluto. The second order, or *minorum gentium*, were called *Adscriptitii*, *Mediosimi*, *Minuscularii*, *Putatitii*, *Indigetæ*, *Semones*, &c. the principal of which were Æsculapius, Bacchus, Castor, Fœna, Hercules, the Lares or Penates, Pollux, Quirinus. See these under their several articles, &c.

According to the second division, all their divinities were classed into, 1. Celestial gods; 2. Terrestrial gods; 3. Sea gods; and, 4. The infernal deities, or *inferi*. The celestial gods were Jupiter, Juno, Apollo, Aurora, Cupid, Cybele, the Graces, Hebe, Iris, Luna, Mars, Mercury, Minerva, Nemesis, Saturn,

Themis, Venus, &c. The terrestrial gods were Æolus, Mythology.—Astræa, Ceres, Diana, the Fauni, Feronia, Flora, Janus, Momus, the Muses, Pales, Pan, Pomona, Priapus, the Satyrs, Silenus, the god Terminus, Vesta or Rhea, Vulcan, &c. The sea-gods were Neptune, Amphitrite, Thetis, Canopus, Glauca, Ino, the Nereids, Nereus, Oceanus, Palemon, Triton, &c. The infernal gods were Pluto, Proserpine, Charon, Minos, Æacus, Rhadamanthus, the Furies, Death, Night, the Fates, Plutus, &c. See these articles.

The third division ranged the divinities according as they presided, 1. Over the pregnancy of women, (*Prægnantium*); 2. At parturitions (*Parturientium*); 3. At births, (*Nascentium*); 4. At adulteries; 5. At marriages: to which they added, 7. *Dii morales*, or moral gods; and, 7. Funeral gods. The gods of pregnancy were Pilumnus, Interdiona, and Deverra: the gods of parturition, Juno, Lucina, Diana, Egerio, Prosa, Postverta, Menagenata, Latona, the gods that were called *Nisi*, or of labour, &c. The gods of birth were Janus, Opis, Nascion, Cunina, Carmenta, Vaginianus, Levana, Rumia, Potina, Educa, Offiagio, Carne, Nundina, Statilinus, Fabulinus, Paventia, &c. The gods of adultery were Juvencus, Agenoria, Strenua, Stimula, Horta, Quies, Murcia, Adæona, Abæona, Voluptas, Orbona, Pellonia, Numeria, Camœna, Sentia, Angeronæ, Heres, Marica, Laverna, the god Averruncus, Conlus, Catus, Volumnus and Volumna, Honorius, Aius Locutius, &c. The nuptial gods were Diana, Domiduca, Domitius, Hymenæus or Hymen, Jugatinus, Jupiter perfectus, Juno perfecta, Juno cinxia, Juno unxia, Lucina, Mantura, Motinus, Dea Mater prima, Suada, Thalassius, Venus, &c. The moral gods were called *Virtus*, *Honor*, *Fides*, *Spes*, *Justitia*, *Pietas*, *Misericordia*, *Clementia*, *Pudicitia*, *Veritas*, *Mens*, *Concordia*, *Pax*, *Salus*, *Felicitas*, *Libertas*, *Pecunia*, *Rifus*, *Invidia*, *Contumelia*, *Impudentia*, *Calumnia*, *Fraus*, *Discordia*, *Furor*, *Fama*, *Fortuna*, with all their epithets good or bad, *Febris*, *Pavor* and *Palor*, *Paupertas*, *Necessitas*, *Tempestas*, *Silentium*, &c. The funeral gods were Pluto, Libitina, Nenia, Death, the Fates, &c.

Hesiod indeed pretends, that all these gods derived their origin from chaos; but we have already pointed out more just sources. It is almost incredible to what a prodigious number the superstition and weakness of the Greeks and Romans multiplied these divinities; there have been 30,000 of them enumerated. It will not be expected that we should here attempt to describe them, nor will it be remarkable if we have forgotten to mention even some of the first rank: although, vast as this company of gods is, mythology does not omit to trace the history of the greatest part of them, as is taught by paganism; and they who are desirous of particular information in these matters may consult with advantage the theogony of Hesiod, the catalogue of Apollodorus, the metamorphoses of Ovid, the fables of Hyginus, Lylis Gregorii Gyraldi Syntagma de diis Gentilium, the mythology of Natalis Comes, the books of Gerard Vossius de idolatria Gentilium, Johannis Boccatii Genealogia deorum, the Pantheon of Pompey, the history of heaven by Abbé Pluche, the historic explanation of fables by Abbé Banier, and Bryant's Mythology.

There

Mythology. There were still many other distinctions, of which the pagans made use to mark the rank, the functions, and nature of their several divinities. For example, the goddesses *Vesta*, or the mother of all the gods, was adored by all people in general. *Mars*, *Bellona*, *Victoria*, *Fortunata*, &c. assisted all parties. The topical gods, on the contrary, were adored in particular countries only; as *Asaric* in Syria, *Derecto* and *Semiramis* among the Assyrians, *Isis* and *Osiris* by the Egyptians, *Quirinus* at Rome, &c. The title *Semones*, which was given to a certain class of divinities, was doubtless derived from *Semi-homines*, that is, *demi-men*; and signified the same as *femi-dii*, or *demi-gods*. These were monarchs and illustrious heroes, or those great men who were the founders of cities and nations, that were deified by way of apotheosis. Pythagoras had taught the Chaldeans the doctrine of transmigration; and that, after their death, those who were virtuous would be elevated to the rank of divinities. This doctrine was adopted by all the pagan world. The apotheosis, after they had erected temples and altars to the new gods, was celebrated with much solemnity. In the last ceremony, an eagle was fixed on the catafalk, or funeral pile, on which was placed the image of the hero; and when the pile began to burn, the eagle was let loose, who, mounting into the air with the flames, seemed to carry the soul of the departed hero up to heaven.

Mythology informs us also who those persons were that antiquity regarded as the children of the gods, such as *Thebes*, *Hippolytus*, *Paris*, &c. what the pagans believed with regard to the nature of their genii and demons, of their dryades, hamadryades, nymphs, tritons, sirens, fauns, sylfens, centaurs, and other subaltern divinities; and in this manner it explains all the systems of the positive religion of the Greeks and Romans. They who are desirous of extending their knowledge of paganism still further, of knowing the dogmas of each particular people, what were their gods, and the various manners in which they were worshipped, such as *Apis*, *Isis*, *Osiris*, &c. the adoration of crocodiles and onions, &c. among the Egyptians, must study the different theogonies of these people; and notwithstanding all the informations which ancient and modern authors afford, this study is yet boundless, and attended with many difficulties and uncertainties: though it appears demonstrative, that the origin of paganism, and of idolatry in general, was derived from the Chaldeans, from whom the Egyptians drew that doctrine which they after transmitted to all other nations; and consequently that the primordial divinities were the same, under different denominations, among all the idolatrous nations of the earth.

The nature of this work will not permit us to descend to further particulars. But to give our readers an idea of the manner in which mythology treats its subjects, and of the method that should be observed in studying fable, or the history of the gods of antiquity, we shall here give, by way of example, a cursory description of *Parnassus* and its inhabitants.

*Parnassus* was a mountain of Phocis, that had two summits, one of which was called *Tithoreus*, and the other *Hyampeus*. Others say, that one of these hills was named *Helicon*, and the other *Cytheron*; and that

it is an error to imagine, that *Helicon* was a mountain of Bœotia. However that be, this double hill was consecrated to *Apollo* and the muses, who there held their usual residence. According to fable, there had been a remarkable combat on this hill, between *Helicon* and *Cytheron*. Whoever slept on *Parnassus*, when he waked, became a poet. *Apollo* had there a temple. There also was the fountain *Castalia*, into which *Apollo* had metamorphosed a nymph that he loved, and had given to its waters the power of making all who drank of them poets. At the foot of *Parnassus* flowed the river *Hippocrene*, that had the same virtue; and the source of which was opened by a stroke of the foot of the horse *Pegasus*. This river nourished a great number of swans, that were regarded as sacred. *Pegasus* was a winged horse, that belonged to *Apollo*, and grazed on the summit of *Parnassus*. He sprang from the blood of *Medusa*, when *Perseus* cut off her head, which was placed among the stars. Such was the delicious abode of *Apollo*, the son of *Jupiter* and *Latona*, who was born, with his twin sister *Diana*, in the island *Delos*. He killed the *Cyclops*, who forged the thunderbolts with which *Jupiter* had overthrown his son *Æsculapius*; but for that presumption he was forced to leave heaven, and became an inhabitant of the earth. He guarded the oxen of *Admetus*; he aided *Neptune* to build the walls of *Troy*, and *Alcetheus* in forming the labyrinth. He killed the dragon or serpent *Python*. He invented music and physic; and was honoured as the god of poets and physicians. He was represented as a young man without a beard, his head surrounded with rays, and bearing in his hand a bow, or a lyre. As the ancients denoted the sun by the name of *Apollo*, they sometimes represented him also as seated in a chariot, drawn by two white horses, preceded by *Aurora* and the star *Venus*: *Phaëton* his son, being desirous of conducting these horses, was thrown into the sea. *Apollo* was also called *Phabus*, *Titan*, and *Sol*. He is known to have had amours with *Arctinoë*, *Corycia*, *Melene*, *Cyrene*, *Mantho*, *Sinope*, *Calliope*, and others; by whom he had *Delphe*, *Naxe*, *Niletus*, *Arabe*, *Garamas*, *Sirus*, *Linus*, *Orpheus*, and other children. He had peculiar honours paid him in the *Pythian* games at *Delphos*, and in the secular games at *Rome*.

The muses were the companions of *Apollo* in his rural abode. They were likewise called the *learned sisters*; as also the *Cæmænon*, *Heliconian*, *Parnassian*, *Aonian*, *Pierian*, *Pegassian*, *Aganippian*, *Theopian*, *Libethrian*, and *Castalian sisters*. They were the daughters of *Jupiter* and *Mnemosyne*, and were regarded as the goddesses of sciences and arts in general. There were nine of those muses; to whom they attributed; 1. To *Clio*, history; 2. To *Melpomene*, tragedy; 3. To *Thalia*, comedy; 4. To *Euterpe*, flutes and other pneumatic instruments of music; 5. To *Terpsichore*, the harp and the dance; 6. To *Erato*, the lyre and the lute; 7. To *Calliope*, heroic verse; 8. To *Urania*, astronomy; and 9. To *Polyhymnia*, rhetoric and eloquence. The *Graces* also sometimes quitted *Venus* to pay their court to *Apollo*.

Such was the idea they entertained of *Parnassus* and its inhabitants. There is no doubt but that, under these fabulous representations, these sensible images, were

Mythology, were concealed allegoric and moral meanings; nor can it be denied but that their method of cultivating the arts and sciences, by this manner of expressing their ideas, was as ingenious and pleasing as it is possible to imagine. Every other subject that paganism embraced, it treated with the same genius, and in a manner equally pleasing; and though that religion was altogether fallacious, yet we must allow that it was extremely well calculated to promote the polite arts, by those refined, noble, graceful, brilliant images, by those charming subjects, which it constantly presented, and which it still offers to the poet, painter, sculptor, and every other artist.

But this was not a power sufficiently strong to secure paganism against that vicissitude, that decline and dissolution, which finally attends all the productions of this world. This religion, which had subsisted near 5000 years, and almost from the origin of the human race, gradually declined in proportion as the lights of Christianity and philosophy illumined the minds of mankind. For though the pagan religion, and the fables on which it was founded, were pleasing and favourable to the polite arts, they were not however calculated to satisfy the minds of philosophers, nor to promote the real good of mankind, by securing their temporal and eternal happiness. It is even surprising that so great a genius as the emperor Julian should attempt to revive the embers of paganism, which intently declined, and had received a mortal blow at the beginning of the fourth century by the emperor Constantine the great. Julian employed all the resources of his imagination, of his eloquence, of his power, and even of his own fatal example, to revive it; but in vain. The period of paganism was arrived, and nothing could save it from destruction. The furious Theodosius, to whom bigotted priests and historians have assigned the name of great, totally overthrew it toward the close of the same century, destroyed those temples and altars which yet subsisted, dispersed its colleges, and exterminated its priests. From that dire epoch, nothing of paganism has remained, except some ruins dispersed in the remote parts of the earth, and among people wretched and almost unknown; where this religion, once so flourishing and universal, is now degenerated into gross and disgusting idolatry.

MYTULUS, the MUSCLE, in ichthyology; a genus of animals, belonging to the order of vermes testacea. The animal is an ascidia: the shell bivalve; often affixed to some substance by a beard; the hinge without a tooth, marked by a longitudinal hollow line. The most remarkable species are, 1. The rugosus, or rugged muscle, with a brittle shell, very rugged, and in shape very irregular; usually oblong, and round at the ends. Its length is near an inch; the colour whitish. It is always found lodged in limestone; the outside appears honey-combed; but the apertures are too small for the shell to pass through, without breaking into the cell they are lodged in. Multitudes are found in the same stone; but each has a separate apartment, with a different external spiracle. 2. The edulus, or edible muscle, has a strong shell, slightly incurved on one side, and angulated on the other. The end near the hinge is pointed; the other rounded. When the

epidermis is taken off, it is of a deep blue colour. Mytulos. It is found in immense beds, both in deep water, and above low-water mark. The finest muscles are those called *Humbleton books*, from a village called *Humbleton* in that county. They are taken out of the sea, and placed in the river Wier, within reach of the tide, where they grow very fat and delicious. 3. The incurvatus, or crooked muscle, is very crooked on one side near the end; then greatly dilated, and covered with a thick rough epidermis. Within it has a violet tinge. It is found on the coast of Anglesea, near Prictholme; usually an inch and an half long. 4. The pellucidus, or pellucid muscle, hath a delicate transparent shell, most elegantly rayed lengthwise with purple and blue; like the former in shape, but more oval; commonly shorter than two inches. It is found in Anglesea, sometimes in oyster-beds, sometimes in trowing over stony bottoms. 5. The umbilicatus, or umbilicated muscle, is nearly of an oval form, the length sometimes five inches. It is a rare and new species; sometimes dredged up off Prictholme island, Anglesea; discovered by the Reverend Mr Hugh Davies. 6. The curtus, or short muscle, with a short, ventricose, obtuse shell, of a dirty yellow colour, length about an inch. 7. The modiolus, or great muscle, with a strong shell, blunted at the upper end; one side angulated near the middle; from thence dilating towards the end, which is rounded. It is the greatest of British muscles, being from six to seven inches in length; it lies at great depths; often seizes the baits of ground-lines, and is taken up with the hooks. 8. The cygnus, or swan muscle, with a thin brittle shell, very broad and convex, marked with concentric striae; attenuated towards one end, dilated towards the other; dearticulated about the hinge; the colour a dull green; the length six inches, breadth three and a half; inhabits fresh waters. 9. The anatinus, or duck muscle, hath a shell more oblong and less convex than the last; is very brittle and semitransparent; the space round the hinges like the last; the length about five inches, breadth two and a quarter; inhabits fresh waters. Crows feed on these muscles, and also on different shell-fish. It is diverting to observe, that when the shell is too hard for their bills, they fly with it to a great height, drop the shell on a rock, and pick out the meat when the shell is fractured by the fall.

The common sea or edible muscle has, from its being always found fastened to the rocks, been supposed by many wholly incapable of progressive motion; but this is an erroneous opinion. It is a common practice in France, at such seasons of the year as do not afford sun enough to make salt, to throw the common sea-muscles, which the fishermen catch about the coasts, into the brine-pits. They have an opinion that this renders their flesh the more tender and delicate, as the rain which falls at these seasons makes the water of the pits much less salt than the common seawater. The muscles are on this occasion thrown carelessly in, in several different parts of the pits; yet, at whatever distances they have been thrown in, the fishermen when they go to take them out, always find them in a cluster together; and as there is no current of water in these places, nor any other power of motion which can have brought the muscles together, it seems

*Mytilus*. seems very evident that they must voluntarily have marched from the places where they were at first, to have met thus together. This progressive motion is wholly performed by means of what we call the *tongue* of the muscle, from its shape; but, from its use in this case, appears rather to merit the name of a *leg*, or an *arm*, as by laying hold of any distant substance, and then forcibly contracting itself again, it draws along the whole body of the fish; the same part, when it has moved the animal to a proper place, serves also to fix it there, being the organ by which it spins the threads which we call its *beard*, by which it is held to a rock, or to another muscle. The motion of the muscle, by means of this part, is just the same with that of a man laid flat on his belly, who would draw himself along by laying hold of any thing with one hand, and then drawing himself to it.

Muscles are well known to have a power of fastening themselves either to stones, or to one another's shells, in a very strong and firm manner; but the method of doing this was not well understood till the observations of Mr Reaumur explained it.

Every one who opens and examines a common muscle, will find, that in the middle of the fish there is placed a little blackish or brownish body resembling a tongue. This in large muscles is near half an inch long, and a little more than a sixth of an inch in breadth, and is narrower at the origin than at the extremity: from the root of this tongue, or that part of it which is fastened to the body of the fish, there are produced a great number of threads, which, when fixed to any solid substance, hold the muscle firmly in its place: these threads are usually from an inch to two inches in length, and in thickness from that of a hair to that of a hog's bristle. They issue out of the shell in that part where it naturally opens, and fix themselves to any thing that lies in their way, to stones, to fragments of shells, or, which is the most common case, to the shells of other muscles; whence it happens that there are usually such large parcels of muscles found together. These threads are expanded on every side, and are usually very numerous, 150 having been found issuing from one shell: they serve the office of so many cables; and, each pulling in its proper direction, they keep the muscle fixed against any force that can be offered from whatever part it come. The filaments are well known to all who eat muscles, who ever carefully separate them under the name of the beard; and Mr Reaumur has found, that while the animal is living in the sea, if they are all torn away by any accident, the creature has a power of substituting others in their room: he found, that if a quantity of muscles were detached from one another and put into a vessel of any kind, and in that plunged into the sea, they in a little time fastened themselves both to the sides of the vessel, and to one another's shells; the extremity of each thread seemed in this case to serve in the manner of a hand to seize upon any thing that it would fix to, and the other part which was slender and smaller to do the office of an arm in conducting it.

To know the manner of the muscles performing this operation, this diligent observer put some muscles into a vessel in his chamber, and covered them with seawater; he there saw that they soon began to open

their shells, and each put forth that little body before described by its resemblance to a tongue, and at the root of which these threads grow; they extended and shortened this part several times, and thrust it out every way, often giving it not less than two inches in length, and trying before, behind, and on every side with it, what were the proper places to fix their threads at: at the end of these trials they let it remain fixed for some time on the spot which they chose for that purpose, and then drawing it back into the shell with great quickness, it was easy to see that they were then fastened by one of these threads to the spot where it had before touched and remained fixed for a few minutes; and in repeating this workmanship the threads are increased in number one at every time, and being fixed in different places they sustain the fish at rest against any common force.

The several threads were found to be very different from one another; the new formed ones being ever whiter, more glossy, and more transparent than the others: and it appeared on a close examination, that it was not, as might have been most naturally supposed, the office of the tongue to convey the old threads one by one to the new places where they were now to be fixed, but that these in reality were now become useless; and that every thread we see now formed, is a new one made at this time; and in fine, that nature has given to some sea-fishes, as well as to many land-insects, a power of spinning those threads for their necessary uses; and that muscles and the like fish are under water, what caterpillars and spiders are at land. To be well assured of this, however, Mr Reaumur cut off the beard or old threads of a muscle as close as he could, without injuring the part; and the proof of the opinion of their spinning new ones at pleasure was now brought to this easy trial, whether these muscles, so deprived of their old ones, could fix themselves as soon as others which were possessed of theirs, and could throw out their threads to as considerable distances. The experiment proved the truth of the conjecture; for those whose beards or old threads were cut off, fixed themselves as soon as those in which they were left, and spread their threads to as great a distance every way.

When the mechanism of this manufacture was thus far understood, it became a natural desire to inquire into the nature of the part by which it was performed: this has hitherto been mentioned under the name of the tongue, from its shape; but it is truly the arm of the fish; and whenever it happens to be loosened from its company, or fixed in a wrong place, it serves the animal to drag its whole body shell and all along, and to perform its several motions. It fixes itself to some solid body; and then strongly contracting its length, the whole fish must necessarily follow it, and be pulled toward the place where it is fixed. This is an use, however, that this part is so rarely put to, that it is not properly to be esteemed a leg or an arm, for this; but, according to its more frequent employment, may much better be denominated the organ by which the threads are spun.

Though this body is flat in the manner of a tongue for the greater part of its length, it is however rounded or cylindrical about the base or insertion, and it is much smaller there than in any other part: there are several

*Mytulus*. Several muscular ligaments fastened to it about the root or base, which hold it firmly against the middle of the back of the shell; of these ligaments there are four which are particularly observable, and which serve to move the body in any direction. There runs all along this body a slit or crack, which pierces very deeply into its substance, and divides it as it were into two longitudinal sections; this is properly a canal, and along this is thrown the liquor which serves to form the threads; and it is in this canal or slit that these threads are moulded into their form. Externally, this appears only a small crack or slit, because the two fleshy sections of the parts almost meet and cover it, but it is rounded and deep within, and is surrounded with circular fibres. This canal is carried regularly on from the tip of the tongue, as it is called, to its base, where it becomes cylindrical; the cylinder in this part being no other than a close tube or pipe, in which this open canal terminates. The cylindrical tube contains a round long body, of the nature of the threads, except that it is much larger; and from the extremity of this all the threads are produced, this serving as a great cable to which all the other little cordages dispersed towards different parts are fixed. The tube or pipe in which this large thread is lodged, seems the reservoir of the liquor of which the other threads are formed; all its internal surface being furnished with glands for its secretion.

The muscle, like many other sea-fishes, abounds in this liquor; and if at any time one touch with a finger the base of this spinning organ, one draws away with it a viscous liquor in form of several threads, like those of the caterpillar, spider, and the other spinning land-animals. The threads fix themselves with equal ease to the most smooth and glossy, as to rougher bodies; if the muscles are kept in glass-jars of sea-water, they as firmly fasten themselves to the glass as to any other body.

Muscles, be they ever so young, have this property of spinning; and by this means they fasten themselves in vast numbers to any thing which they find in the sea. Mr Reaumur has seen them when as small as millet seeds, spin plentifully; tho' their threads, proportioned to their own weight, are much finer and smaller than those of larger muscles.

It is a question yet undetermined, whether the muscle has a power of breaking or otherwise getting rid of its threads, in order to its removing from the place where it is once fixed; but it appears probable that they have not, and that they must remain where they have once fastened themselves, tho' their destruction be the consequence of it. Mr Reaumur tried this experiment in his jars: when they had well fixed themselves to the sides of them, he poured off part of the salt-water, so that it became the interest of the fish to leave their hold and go lower down, but they seemed to have no power to effect this.

The common muscle affords the curious observer a very pleasing object of examination by the microscope. The transparent membrane, which immediately ap-

pears on opening the shell, shews the circulation of the blood for a long time together through an amazing number of vessels. And Mr Lewenhoeck, in several which he dissected, discovered numbers of eggs or embryo muscles in the ovarium, appearing as plainly as if he had seen them by the naked eye, and all lying with their sharp ends fastened to the string of vessels by which they receive nourishment. The minute eggs, or embryos, are by the parent placed in due order, and in a very close arrangement on the outside of the shell, where, by means of a gluey matter, they adhere very fast, and continually increase in size and strength, till becoming perfect muscles, they fall off and shift for themselves, leaving the holes where they were placed, behind them.

This abundance of muscle-shells very plainly shew when examined by the microscope, and sometimes they are in the number of 2000 or 3000 on one shell: but it is not certain that these have been all fixed there by the muscle within; for these fish usually lying in great numbers near one another, the embryos of one are often affixed to the shell of another. The fringed edge of the muscle, which Lewenhoeck calls the *beard*, has in every the minutest part of it such variety of motions as is inconceivable; for being composed of longish fibres, each fibre has on both sides a vast many moving particles.

From the common muscles abundance of small pearls, called *seed-pears*, were, till of late, procured for medical purposes; but they are now disused since it became generally known, that the cheaper testaceous powders were equally efficacious with these. Pearls are also found in the two last species.—Muscles sometimes disagree with those who eat them, bringing on swellings, difficulty of breathing, blotches, and sometimes even death. The cure is oil mixed with salt water.

MYUS, (anc. geog.), one of the twelve towns of Ionia; seated on the Meander, at the distance of 30 stadia from the sea. In Strabo's time it was incorporated with the Milesians, on account of the paucity of its inhabitants, from its being formerly overwhelmed with water; for which reason the Ionians assigned its suffrage and religious ceremonies to the people of Miletus. Artaxerxes allotted this town to Themistocles, in order to furnish his table with provisions. The town now lies in ruins.

MYXINE, the HAG; a genus of insects belonging to the order of vermes intestini. It hath a slender body, carinated beneath; mouth at the extremity, ciliated; the two jaws pinnated; an adipose or rayless fin round the tail and under the belly. The only remarkable species is the glutinosa, about eight inches long. It inhabits the ocean; enters the mouths of fish when on the hooks of lines that remain a tide under water, and totally devours the whole, except skin and bones. The Scarborough fishermen often take it in the robbed fish, on drawing up their lines. Linnaeus attributes to it the property of turning water into glue.

## N.

N  
Nabouassar.

**N**, A liquid consonant, and the 13th letter of the Greek, Latin, English, &c. alphabets.

The *n* is a nasal consonant: its sound is that of a *d*, passed through the nose; so that when the nose is stopped by a cold, or the like, it is usual to pronounce *d* for *n*. M. l'Abbé de Dangeau observes, that in the French, the *n* is frequently a mere nasal vowel, without any thing of the consonant in it. He calls it the Slavonic vowel. The Hebrews call their *n* *nun*, which signifies child, as being supposed the offspring of *m*; partly on account of the resemblance of sound, and partly on that of the figure. Thus from the *m*, by omitting the last column, is formed *n*; and thus from the capital N, by omitting the first column, is formed the Greek minuscule  $\nu$ . Hence for *biennies*, &c. the Latins frequently use *binus*, &c. and the same people convert the Greek  $\nu$ , at the end of a word into an *m*, as  $\varphi\alpha\rho\mu\alpha\kappa\omicron\nu$ , *pharmacum*, &c. See M.

*N* before *p*, *b*, and *m*, the Latins change into *m*, and frequently into *l* and *r*; as in *in-ludo*, *illudo*; *ir-rigo*, *ir-rigo*, &c.: in which they agree with the Hebrews, who, in lieu of *nun*, frequently double the following consonants; and the Greeks do the same; as when for *Manlius*, they write  $\text{ΜΑΝΝΙΟΥΣ}$ , &c. The Greeks also, before  $\kappa$ ,  $\gamma$ ,  $\chi$ ,  $\nu$ , changed the *v* into  $\gamma$ ; in which they were followed by the ancient Romans; who, for *Angulus*, wrote *Aggulus*; for *anceps*, *ag-seps*, &c.

The Latins retrench the *n* from Greek nouns ending in *ov*; as *Asus*, *Leo*;  $\delta\rho\alpha\kappa\omicron\nu$ , *Draco*; on the contrary, the Greeks add it to the Latin ones ending in *o*; as *Katov*, *Nepov*, for *Cato*, *Nero*.

**N**, among the ancients, was a numeral letter, signifying 900; according to the verse in Baronius,

*N, quaque nonagesimo numero designat habendus.*

And when a line was struck over it,  $\bar{N}$ , nine thousand. Among the ancient lawyers *N. L.* stood for *non liquet*, i. e. the cause is not clear enough to pass sentence upon. **N**, or  $N^o$ , in commerce, &c. is used as an abbreviation of *numero*, number.

**NABIS**, tyrant of Sparta, reigned about 204 B. C.; and is reported to have exceeded all other tyrants for far, that, upon comparison, he left the epithets of *gracious* and *merciful* to Dionysius and Phalaris. He is said to have contrived an instrument of torture in the form of a statue of a beautiful woman, whose rich dress concealed a number of iron spikes in her bosom and arms. When any one therefore opposed his demands, he would say, "If I have not talents enough to prevail with you, perhaps my woman Apega may persuade you." The statue then appeared; which Nabis taking by the hand, led up to the person, who, being embraced by it, was thus tortured into compliance. He reigned 14 years, and was slain in battle.

**NADOB**, a viceroy, or governor of one of the provinces of the Mogul's empire.

**NABONASSAR**, first king of the Chaldeans, or

Babylonians; memorable for the Jewish æra which Nabopolassar bears his name, which is generally fixed in 3257, beginning on Wednesday February 26th in the 3967th of the Julian period, 747 years before Christ. The Babylonians revolting from the Medes, who had overthrown the Assyrian monarchy, did, under Nabonassar, found a dominion, which was much increased under Nebuchadnezzar. It is probable, that this Nabonassar is that Baladan in the second of Kings xx. 12. father of Merodach, who sent ambassadors to Hezekiah. See 2 Chron. xxxii.

**NABOPOLASSAR**, king of Babylon: he joined with Astyages the Mede, to destroy the empire of Assyria; which having accomplished, they founded the two empires of the Medes under Astyages, and the Chaldeans under Nabopolassar, 627 B. C.

**NABUCHADNEZZAR**, or **NABUCHODONOSOR II.** king of Assyria, son of Nabopolassar, and styled the *Great*, was associated by his father in the empire, 607 B. C. and the following year he took Jehoiakim king of Judah prisoner, and proposed to carry him and his subjects in captivity into Babylon; but upon his submission, and promising to hold his kingdom under Nabuchodonosor, he was permitted to remain at Jerusalem. In 603 B. C. Jehoiakim attempted to shake off the Assyrian yoke, but without success; and this revolt brought on the general captivity. Nabuchadnezzar having subdued the Ethiopians, Arabians, Idumæans, Philistines, Syrians, Persians, Medes, Assyrians, and almost all Asia; being puffed up with pride, caused a golden statue to be set up, and commanded all to worship it; which Daniel's companions refusing to do, they were cast into the fiery furnace. But as he was admiring his own magnificence, by divine sentence, he was driven from men, and did eat grass as oxen, that is, he imagined himself to be one. At the end of seven years his reason returned to him, and he was restored to his throne and glory. He died 562 B. C. in the 43d year of his reign; in the 5th of which happened that eclipse of the sun mentioned by Ptolemy, which is the surest foundation of the chronology of his reign.

**NADIR**, in astronomy, that point of the heavens which is diametrically opposite to the zenith, or point directly over our heads.

**NAERDEN**, a strong town of the United Provinces in Holland, seated at the head of the canals of the province. The foundations of it were laid by William of Bavaria, in 1350. It was taken by the Spaniards in 1572, and by the French in 1672; but it was retaken by the prince of Orange the next year. It stands at the south end of the Zuyder-Zee, in E. Long. 5. 3. N. Lat. 51. 22.

**NÆVIUS** (Cneius), a famous poet of Campania, was bred a soldier, but quitted the profession of arms, in order to apply himself to poetry, which he prosecuted with great diligence; and composed a history in verse, and a great number of comedies. But it is said, that



Nævus,  
Nægera.Nagracut  
Nairn.

that his first performance of this last kind fo displeafed Metellus, on account of the fatyrical ftrokes it contained, that he procured his being banifhed from the city; on which he retired to Utica in Africa, where he at length died, 202 B. C. We have only fome fragments left of his works.

**NÆVUS**, a mole on the fkin, generally called a *mother's mark*; alfo the tumour known by the name of a *wen*.

All preternatural tumours on the fkin, in the form of a wart or tubercle, are called *excrefcences*; by the Greeks they are called *acrothymia*; and when they are born with a perfon, they are called *nævi materni*, or *marks from the mother*. A large tumour depending from the fkin is denominated *farcoma*. Thefe appear on any part of the body: fome of them differ in their colour from the reft of the fkin; whitft others are red, black, &c. Their fhape is various; fome refembling ftrawberries, others grapes, &c. Heifter advifes their removal by means of a ligature, a cautery, or a knife; as circumftances beft fuit.

As to the tumour called a *wen*, its different fpecies are diftinguifhed by their contents. They are encyfted tumours; the matter contained in the firft three following is infpiffated lymph, and that in the fourth is only fat. Monf. Litre is the firft who hath particularly defcribed the fourth kind; and to the following purpofe he fpeaks of them all. A wen is faid to be of three forts, according to the kind of matter it contains: thofe whofe contents refemble boiled rice, or curds, or a bread-poultice, is called *atheroma*; if it refembles honey, it is named *melleæris*; and if it is like fuet, it is denominated *fteatoma*: but there is a fourth fort, which may be called *lipome*, becaufe of its fat contents refembling greafe. He fays that he hath feen one on the foulders of a man, which was a thin bag, of a tender texture, full of a foft fat, and that it had all the qualities of common greafe. And though the fat in the lipome refembles that in the *fteatoma*, yet they cannot be the fame: for the matter of the *fteatoma* is not inflammable, nor does it melt; or if it does, it is with great difficulty and imperfectly; whereas it is the contrary with the lipome. When the man who had the above-named lipome was fatigued, or had drank freely of ftrong liquors, his lipome was inflamed for fome days after, and its contents rarefying increafed the fize of the tumour.

The lipome feems to be no other than an enlargement of one or more of the cells of the adipofe membrane, which is filled only with its natural contents. Its foftnefs and largenefs diftinguifh it in general from the other fpecies, though fometimes the fatty contents will be fo hard as to deceive. As this kind of wen does not run between the mufcles, nor is poffeffed of any confiderable blood-veffels, it may always be cut off with eafe and fafety.

As to the other kind of wens, their extirpation may or may not be attempted, according as their fituation is with refpect to adjacent veffels, the wounding of which would endanger the patient's life.

**NAGERA**, or **NAGARA**, a town of Spain, in Old Caftile, and the territory of Rioja, with the title of a duchy and fterres; famous for a battle fought in its neighbourhood in 1369. It is fituated in a fertile country, on a brook called *Naferrilla*. W. Long. 2. 20.

N. Lat. 42. 25.

**NAGRACUT**, a town of India, the capital of a kingdom of the fame name in the dominions of the Great Mogul, with a rich temple to which the Indians go in pilgrimage. It is feated on the river Ravi. E. Long. 78. 10. N. Lat. 33. 12.

**NAHUM**, or the *Prophecy of NAHUM*, a canonical book of the Old Teftament.

**NAHUM**, the feventh of the 12 leffer prophets, was a native of Elkofhai, a little village of Galilee. The fubject of his prophecy is the deftruction of Nineveh, which he defcribes in the moft lively and pathetic manner; his ftyle is bold and figurative, and cannot be exceeded by the moft perfect mafters of oratory. This prophecy was verified at the fiege of that city by Aftiyages, in the year of the world 3378, 622 years before Chrift.

**NAIADES**, in pagan mythology, the nymphs of rivers and fountains, who were adored by the pagans as a kind of inferior deities, and were reprefented as young and beautiful virgins.

**NAIANT**, in heraldry, a term ufed in blazoning fifhes, when borne in an horizontal pofure, as if swimming.

**NAIL**, **UNGUIS**, in anatomy. See there, n<sup>o</sup> 80.

**NAILS**, in building, &c. fmall fpikes of iron, brafs, &c. which being drove into wood, ferve to bind feveral pieces together, or to faften fomething upon them.

**NAIL**, is alfo a meafure of length, containing the 16th part of a yard.

**NAILING of Cannon**. When circumftances make it neceffary to abandon cannon, or when the enemy's artillery are feized, and it is not however poffible to take them away, it is proper to nail them up, in order to render them ufelefs; which is done by driving a large nail or iron fpike into the vent of a piece of artillery, to render it unferviceable. There are various contrivances to force the nail out, as alfo fundry machines invented for that purpofe, but they have never been found of general ufe; fo that the beft method is to drill a new vent.

One Gafper Vimercalus was the firft who invented the nailing of cannon. He was a native of Bremen, and made ufe of his invention firft in nailing up the artillery of Sigifmund Malatefta.

**NAIN** (Lewis Sebastian de), one of the moft learned and judicious critics and hiftorians France has produced, was born in 1637. He was remarkable for his humility and piety, and died in 1698. His principal works are, 1. *Memoirs on the ecclefiaftical hiftory of the fix firft ages of the church*, 16 vols 4to. 2. *The hiftory of the emperors*, 6 vols 4to.

**NAIRN**, a county of Scotland, comprehending the weft part of Murray. It is bounded on the north by Murray frith, on the weft and fouth by Invernefs, and on the eaft by Elgin. The length of it amounts to 20 miles, and the breadth to 14. The air is temperate and falubrious, and the winters are remarkably mild. The face of the country is rough and mountainous; yet there are fome fruitful ftراثs, or valleys, which produce good crops of oats and barley; but in general the country is much better adapted for palturage. Here are alfo large woods of fir, and other trees, that afford fhelter to the game, of which there is great plenty. A ftراث is a long, narrow valley, with a ri-

Naissant  
||  
Name.

ver running through the bottom. Of these, the most remarkable in this county, are Strath-nairn, on the river of that name, in the fourth-west part of the shire; and on the south-east side, Strath-erin, on both sides of Findhorne river. Nairn is well watered with streams, rivulets, and lakes, abounding with fish. In the southern part there is a small lake, called *Moy*, surrounding an island, on which there is a castle belonging to the laird of M'Intosh: but the greater part of the shire is peopled by the Frasers, a warlike Highland clan, whose chief, the Lord Lovat, lost his life on a scaffold, for having been concerned in the late rebellion. Here is a great number of villages; but no towns of note, except Nairn, supposed to be the *Taugeti* of Ptolemy, situated at the mouth of the river which bears the same name; a royal borough, which gave a title of lord to an ancient family, forfeited in the rebellion of 1715. The harbour, which opened in the Murray frith, is now choked up with sand; and the commerce of the town is too inconsiderable to deserve notice. The people in general subsist by feeding sheep and black cattle. About four miles from Nairn stands the castle of Calder, on the river of that name, belonging to a branch of the family of Campbell. In this neighbourhood we find a quarry of free-stone, and many signs of copper. About six miles to the north-west of Nairn, a new fort hath been lately built by the order of the government, at a place called *Ardsferer*, a small isthmus upon the Murray frith, which it is intended to command.

NAISSANT, in heraldry, is applied to any animal issuing out of the midst of some ordinary, and shewing only his head, shoulders, fore-feet, and legs, with the tip of his tail; the rest of his body being hid in the shield, or some charge upon it: in which it differs from *issuant*, which denotes a living creature arising out of the bottom of any ordinary or charge.

NAKED SEEDS, in botany, those that are not inclosed in any pod or case.

NAME, denotes a word whereby men have agreed to express some idea; or which serves to denote or signify a thing or subject spoken of. See WORD.

This the grammarians usually call a *noun*, *nomen*, though their noun is not of quite so much extent as our name. See NOUN.

Seneca, Lib. II. *de Beneficiis*, observes, that there are a great number of things which have no name; and which, therefore, we are forced to call by other borrowed names. *Ingens est, says he, rerum copia sine nomine, quas cum propriis appellationibus signare non possumus, alienis accommodatis utimur:* which may shew why, in the course of this dictionary, we frequently give divers senses to the same word.

Names are distinguished into *proper* and *appellative*. *Proper* NAMES, are those which represent some individual thing or person, so as to distinguish it from all other things of the same species; as, *Socrates*, which represents a certain philosopher.

*Appellative* or *General* NAMES, are those which signify common ideas; or which are common to several individuals of the same species; as, *horse*, *animal*, *man*, *oak*, &c.

Proper names are either called *Christian*, as being given at baptism; or surnames: The first imposed for distinction of persons, answering to the Roman *pre-*

*nomen*: The second, for the distinction of families, answering to the *nomen* of the Romans, and the *patronymicum* of the Greeks.

Originally every person had but one name; as among the Jews, *Adam*, &c. among the Egyptians, *Bufris*; among the Chaldees, *Ninuz*; the Medes, *Abyages*; the Greeks, *Diomedes*; the Romans, *Romulus*; the Gauls, *Divitiacus*; the Germans, *Arvostus*; the Britains, *Cassibelan*; the English, *Hengist*, &c. And thus of other nations, except the savages of Mount Atlas, whom Pliny and Marcellinus represent as *anonyme*, "nameless."

The Jews gave the name at the circumcision, *viz.* eight days after the birth; the Romans, to females the same day, to males the ninth; at which time they held a feast, called *nominalia*.

Since Christianity has obtained, most nations have followed the Jews, baptizing and giving the name on the eighth day after the birth; except our English ancestors, who, till of late, baptized and gave the name on the birth-day.

The first imposition of names was founded on different views, among different people; the most common was to mark the good wishes of the parents, or to entitle the children to the good fortune of a happy name seemed to promise. Hence, *Victor*, *Castor*, *Fauftus*, *Statorius*, *Probus*, &c.

Accordingly, we find such names, by Cicero called *bona nomina*, and by Tacitus *fausta nomina*, were first enrolled and ranged in the Roman registers; first called to serve at the sacrifices, in the foundation of colonies, &c.—And, on the contrary, Livy calls *Aturia Ueber*, *abominandi omnis nomen*; and Plautus, on occasion of a person named *Lycos*, i. e. "greedy wolf," says;

*Vosmet nunc facite conjecturam ceterum  
Quid id sit hominis, cui Lycos nomen sit.*

Hence, Plato recommends it to men to be careful in giving happy names; and the Pythagoreans taught expressly, that the minds, actions, and successes of men, were according to their names, genius, and fate. Thus Panormitan, *ex bono nomine oritur bona presumptio*; and the common proverb, *Bonum nomen bonum omen*; and hence the foundation of the onomomantia. See ONOMOMANTIA.

Hence Camden takes it for granted, that the names, in all nations and languages, are significative, and not simple sounds for mere distinction sake. This holds not only among the Jews, Greeks, Latins, &c. but even the Turks; among whom, *Abdalla* signifies *God's servant*; *Soliman*, *peaceable*; *Mahomet*, *glorified*, &c. And the savages of Hispaniola, and throughout America, who, in their languages, name their children, *Glistering Light*, *Sun Bright*, *Fine Gold*, &c.; and they of Congo, by the names of precious stones, flowers, &c.

To suppose names given without any meaning, however by the alteration of languages their signification may be lost, that learned author thinks is to reproach our ancestors; and that contrary to the sense of all ancient writers. Porphyry notes, that the barbarous names, as he calls them, were very emphatical, and very concise: and accordingly, it was esteemed a duty to be *εργασιας, or sui nominis homines*: as Severus, *Probus*,

Name.

Name. Probus, and Aurelius, are called *sui nominis imperatores*.

It was the usual way of giving names, to wish the children might discharge their names.—Thus when Gunthram king of France named Clotharius at the font, he said, *Crescat puer, & hujus sit homines ex-cutor*.

The ancient Britons, Camden says, generally took their names from colours, because they painted themselves; which names are now lost, or remain hid among the Welsh. When they were subdued by the Romans, they took Roman names, some of which still remain, corrupted; though the greatest part became extinct upon the admission of the English Saxons, who introduced the German names, as *Cridda, Penda, Oswald, Edward, &c.*—The Danes, too, brought with them their names; as *Suayne, Harold, Knute, &c.* The Normans, at the Conquest, brought in other German names, as originally using the German tongue; such as *Robert, William, Richard, Henry, Hugh, &c.* after the same manner as the Greek names: *Aspasius, Boethius, Symmachus, &c.* were introduced into Italy upon the division of the empire. After the Conquest, our nation, which had ever been averse to foreign names, as deeming them unlyckly, began to take Hebrew names; as *Matthew, David, Sampson, &c.* The various names anciently or at present obtaining among us, from what language or people soever borrowed, are explained by Camden in his Remains. As to the period when names began to be multiplied, and surnames introduced, &c. see SURNAME.

Of late years it has obtained among us to give surnames for Christian names; which some dislike, on account of the confusion it may introduce. Camden relates it as an opinion, that the practice first began in the reign of Edward VI. by such as would be god-fathers, when they were more than half fathers. Upon which some were persuaded to change their names at confirmation; which, it seems, is usual in other countries.—Thus, two sons of Henry II. of France, christened *Alexander* and *Hercules*, changed them at confirmation into *Henry* and *Francis*. In monasteries, the religious assume new names at their admittance, to shew they are about to lead a new life, and have renounced the world, their family, and even their name: *v. g.* sister *Mary of the Incarnation*, brother *Henry of the holy Sacrament, &c.* The popes also changed their name at their exaltation to the pontificate; a custom first introduced by Pope Sergius, whose name till then, as Platina informs us, was *Swine-snout*. But Onuphrius refers it to John XII or XIII.; and at the same time adds a different reason for it from that of Platina, viz. that it was done in imitation of St Peter and St Paul, who were first called *Simon* and *Saul*.

Among the ancients, those deified by the Heathen consecrations, had new names given them; as Romulus was called *Quirinus*; Melicertes, *Portunus* or *Portunus*, &c.

New names were also given in adoptions, and sometimes by testament: thus L. Æmilius, adopted by Scipio, took the name of *Scipio Africanus*; and thus Augustus, who at first was called *G. Octavius Thurinus*, being adopted by the testament of Julius Cæsar into his name and family, took the name of *Gaius Julius*

*Cæsar Octavianus.*

Names were also changed at enfranchisements into new cities. Thus Lucumo, at his first being made free of Rome, took the name *Lucius Targuntius Priscus, &c.*; and slaves, when made free, usually assumed their masters names. Those called to the equestrian order, if they had base names, were always new named, *nomine ingenuorum veterumque Romanorum.* And among the primitive Christians, it was the practice to change the names of the catechumens: Thus the renegade Lucianus, till his baptism, was called *Lucius*.

NAMUR, a province of the Netherlands, lying between the rivers Sambre and Maefe; bounded on the north by Brabant, on the east and south by the bishopric of Liege, and on the west by Hainault. It is pretty fertile; has several forests, marble quarries, and mines of iron, lead, and pit-coal; and is about 30 miles long, and 20 broad. Namur is the capital town.

NAMUR, a large, rich, and very strong town of the Netherlands, capital of the county of Namur, with a strong castle, several forts, and a bishop's see. The most considerable forts are, Fort-William, Fort-Maefe, Fort Coquelet, and Fort-Espinor. The castle is built in the middle of the town, on a craggy rock. It was besieged by king William in 1695, who took it in the fight of an army of 100,000 French, though there were 60,000 men in garrison. Namur is now a barrier-town, and has a Dutch garrison. It was ceded to the house of Austria in 1713, but taken by the French in 1746; and restored by the treaty of Aix-la-Chapelle. It is situated between two mountains, at the confluence of the rivers Maefe and Sambre, in E. Long. 4. 57. N. Lat. 50. 25.

NANCI, a town of France, and capital of Lorraine, is situated on the river Meuse, in the centre of the province. It is divided into the Old and New Towns, The first, though irregularly built, is very populous, and contains the ducal palace: the streets of the New Town are as straight as a line, adorned with handsome buildings, and a very fine square. The primal church is a magnificent structure, and in that of the Cordeliers are the tombs of the ancient dukes. The two towns are separated by a canal; and the new town was very well fortified, but the king of France has demolished the fortifications. It has been taken and retaken several times; particularly by the French, to whom it was ceded in 1736, to enjoy it after the death of Stanislaus.

NANKING, a city of China, and capital of the province of Kiang-nan. It is the largest in China, being 17 miles in circumference, and about three miles distant from the great river Yang-tse Chiang, from which there are canals cut, so large that vessels may enter the town. This place is greatly fallen from its ancient splendour, for it had a magnificent palace, which is quite destroyed, as well as many ancient monuments, and a third part of the city itself is desolate. The streets are narrow, but handsome and well paved, and on each side are shops neatly furnished. The public buildings are mean, except a few temples, the city-gates, and a tower of porcelain 200 feet high. They have several manufactures of silk and wool. The number of the inhabitants are said to be 1,000,000, without

Namur  
#  
Nanking.

Nansio  
||  
Nantuel.

without comprehending the garrison of 40,000 men. E. Long. 119. 25. N. Lat. 32. 46.

**NANSIO**, an island of the Archipelago, a little to the north of the island of Santorino, 16 miles in circumference; but has no harbour. The mountains are nothing but bare rocks, and there are not springs sufficient to water the fields. There are a vast number of partridges, whose eggs they destroy every year to preserve the corn, and yet vast numbers of them are always produced. The ruins of the temple of Apollo are yet to be seen, and consist chiefly of marble columns. E. Long. 26. 20. N. Lat. 36. 15.

**NANTES**, an ancient, rich, and very considerable town of France, in Bretagne, with a bishop's see, an university, and a mint. It is one of the most considerable places in the kingdom; contains the richest merchants; and was formerly the residence of the dukes of Bretagne, where they built a very strong castle on the side of the river, and which is strongly fortified. There are several parishes, and a great many religious houses, and the cathedral contains the tombs of the ancient dukes. There are several fine bridges over the river Loire, which is navigable. The suburbs are so large, on account of the number of people that come from all parts to settle here, that they exceed the city. The Spaniards trade here with wine, fine wool, iron, silk, oil, oranges, and lemons; and they carry back cloth, stuffs, corn, and hard-ware. The Dutch send salt fish, and all sorts of spices; and in return have wine and brandy. The Swedes bring copper; and the English, lead, tin, and pit-coal. It was in this place that Henry IV. promulgated the famous edict in 1598, called the *Edict of Nantes*, and which was revoked in 1685. The territory of Nantes lies on both sides the Loire, and feeds a great number of cattle. Large vessels can come no higher than Port Launai, which is 12 miles from Nantes. W. Long. 1. 31. N. Lat. 47. 13.

**NANTUEIL** (Robert), the celebrated designer and engraver to the cabinet of Lewis XIV. was born at Rheims in 1630. Though his father was but a petty shopkeeper, he gave his son a liberal education; who, having a taste for drawing, cultivated it with such success, that he became the admiration of the whole town: but marrying young, and not being able to maintain his family, he took a journey to Paris, where he made his talents known by a stratagem.—Seeing several abbés at the door of an eating-house, he asked the mistress for an ecclesiastic of Rheims, whose name he had forgot, but that he might easily know him by a picture of him which he shewed: the abbés crowding round, were so charmed with it, that he seized the opportunity of offering to draw any of their pictures for a small matter. Customers came so fast that he soon raised his price, and brought his family to Paris, where his reputation was quickly established. He applied himself particularly to taking portraits in crayons, which he afterward engraved for the use of academical theses; and in this way he did the portrait of the king, and afterward engraved it as big as the life; a thing never before attempted. The king was so pleased with it, that he created the place of designer and engraver to the cabinet for him, with a pension of 1000 livres. He died in 1678; and an entire collection of his prints amounts to upwards of 240.

Napæa  
||  
Napier.

**NAPÆA**, in botany; a genus of the polyginia order, belonging to the monadelphia class of plants. There are two species; both of them with perennial roots, composed of many thick fleshy fibres, which strike deep into the ground, and are connected at the top into large heads; the stalks grow to seven or eight feet high, producing white flowers, tubulous at bottom, but spreading open at top, and dividing into five obtuse segments. Both these plants are natives of Virginia and other parts of North America: from the bark of some of the Indian kinds a sort of fine hemp might be procured, capable of being woven into very strong cloth. They are easily propagated by seed, which will thrive in any situation.

**NAPHTHA**, in natural history, a fluid mineral body, of a thin consistence, bright and pellucid, of a strong smell, very readily inflammable, and, when pure, burning away without leaving any residuum.

The naphtha is found in considerable quantities floating on the water of certain springs, principally breaking out at the sides of hills in Persia, Tartary, and some parts of the empire of China; where, if a lighted candle be held near the surface, it takes fire and overpreads the surface of the water for a great extent with a strong white flame, and emits a very disagreeable smell. The genuine naphtha is very rare in Europe; it is not known to be any where naturally produced here, and what we see of it is generally sophisticated. Distilled by the retort, it yields an oil somewhat thinner than it was originally, and of a weaker smell. The substance remaining at the bottom of the retort, has much the resemblance of amber; and Dr Hill thinks it highly probable, that the origin of all the amber is from the same sort of principle; nay, he tells us that he has succeeded so far in an attempt to make amber by this fluid and an acid drawn from the crude pyrites, that he has produced a friable, somewhat pellucid matter, having all the properties of amber except the hardness and cleanness, and yielding a true salt and oil of amber on distillation. The medicinal virtues of the naphtha are the same with that of the common petroleum, but in a lower degree. It is used externally on many occasions in Persia; and is taken inwardly, a few drops for a dose, in colics. The principal use of it, however, is for burning in lamps; and for this it is extremely well adapted.

**NAPHTHALI**, or **NEPHTHALI**, (Josh. xix.) one of the tribes of Israel; having Zabulon on the south, Asher on the west, the Jordan on the east, and on the north Antilibanus.

**NAPIER**. See **NEPER**.

**NAPLES**, a kingdom of Italy, comprehending the ancient countries of Samnium, Campania, Apulia, and Magna Græcia. It is bounded on all sides by the Mediterranean and Adriatic, except on the north-east, where it terminates on the Ecclesiastical state. Its greatest length from south-east to north-west is about 280 English miles; and its breadth from north-east to south-west, from 96 to 120.

The ancient history of this country falls under the articles **ROME** and **ITALY**; the present state of it, as well as of the rest of Italy, is owing to the conquests of Charlemagne. When that monarch put an end to the kingdom of the Lombards, he obliged the dukes of Friuli, Spoleto, and Benevento, to acknow-  
ledge

Naples. ledge him as king of Italy; but allowed them to exercise the same power and authority which they had enjoyed before his conquest. Of these three dukedoms Benevento was by far the most powerful and extensive, as it comprehended almost all the present kingdom of Naples; that part of Farther Calabria beyond the rivers Savuto and Peto, a few maritime cities in Higher Calabria, with the city of Acropoli, and the promontory in its neighbourhood called *Capo di Licofa*; and lastly, the dukedoms of Gaeta, Naples, and Amalfi, which were very inconsiderable, and extended along the shore only about 100 miles, and were interrupted by the Gallatate or county of Capua.

This flourishing and extensive dukedom was at this time governed by Arechis, who had married one of the daughters of the last king of the Lombards, and had submitted, and taken the oath of allegiance to the emperor Charles. However, a few years after, he renounced his allegiance to the Franks, declared himself an independent sovereign, and was acknowledged as such by all the inhabitants of his duchy. To strengthen himself against Pepin king of Italy, who resided at Ravenna, he enlarged and fortified the city of Benevento, and likewise built Salerno on the sea-coast, surrounding it with a very strong and high wall. He engaged in several wars with the Greeks, whom he sometimes obliged to give him hostages; but having invaded the territories of the pope, whom Pepin could not assist, Charlemagne prevailed on to return to Italy. Arechis, unable to oppose such a formidable enemy, sent his eldest son, Romuald, to Rome, with an offer of submission: but, at the instigation of the pope, Charles refused the offer, and detained his son prisoner; after which he ravaged the country, and made himself master of Capua. Other deputies, however, proved more successful; and, in the year 787, a peace was concluded on these conditions: That Arechis and the Beneventans should renew their allegiance to the Franks; that he should pay a yearly tribute to Pepin; deliver up all his treasure; and give his son Grimoald and his daughter Adalgisa, with twelve others, as hostages for his fidelity: however, after many intreaties, Adalgisa was restored to her father.

Charles had no sooner left Italy, than Arechis forgot all his engagements, and began to negotiate with Irene, empress of Constantinople, and her son Constantine, for expelling the Franks out of Italy. For himself, he desired the honour of patriaric, and the dukedom of Naples with all its dependencies; and, in return, promised to acknowledge the Greek emperor as his sovereign, and to live after the manner of the Greeks. He required, however, to be supported by a Greek army; and that his brother-in-law Adalgisus, son to Desiderius the last king of the Lombards, should be sent over into Italy, to raise a party among his countrymen. These conditions were readily accepted, on condition that prince Romuald should be sent as a hostage; ambassadors were sent to Naples with the ensigns of the patrician order, namely the mantle of cloth of gold, the sword, the comb, and the sandals: but before the ceremony could be performed, prince Romuald died, and soon after him his father; whose death was supposed to have been hastened by that of his son.

After the death of Arechis, the Beneventans sent a most submissive embassy to Charlemagne, intreating him to send them Grimoald, the late king's son, and only lawful heir to his crown; threatening at the same time to revolt if their prince was denied them. Charles readily granted their request, and allowed Grimoald to depart, after he had agreed to the following conditions, viz. That he should oblige the Lombards to shave their beards; that, in writings, and on money, the name of the king should be put before that of the prince; and that he should cause the walls of Salerno, Acerenza, and Confia, to be entirely demolished.— The new king was received by his subjects with the utmost joy; and for some time continued faithful to his engagements, excepting only the last article, which he either neglected or eluded. So far, however, was he from assisting the Greeks, that he gave notice of their machinations to Pepin king of Italy; raised an army to oppose his uncle Adalgisus; and being joined by Hildebrand duke of Spoleto, and Vinigie the general of Pepin, he attacked the Greeks in Calabria soon after they had landed, entirely defeated and took his uncle prisoner, and, as is said, put him to a cruel death. Yet in a short time Grimoald contracted an alliance with the Greek emperor by marrying his niece Wanzia; and in the fifth year of his reign, a war broke out between him and Pepin, which continued for twelve years; at the end of which time a truce was concluded. Grimoald survived this pacification only three years, and was succeeded by his treasurer Grimoald II. who submitted to Charlemagne after the death of Pepin, and from this time the Beneventans were looked upon as tributaries of the western emperors. As yet, however, the city of Naples did not own allegiance to the dukes of Benevento, but was held by the eastern emperors; and frequent wars took place between the Beneventans and Neapolitans. This happened to be the case when Grimoald II. ascended the throne. He concluded a peace with them: which however, was of no long continuance; for Theodore, governor of Naples, having granted protections to Dauforius a noble Beneventan, who had been concerned in a conspiracy against his prince, Grimoald marched against the city of Naples, and invested it by sea and land. Theodore still refused to deliver up the traitor, and a general engagement both by land and sea was the consequence; in which the Neapolitans were defeated with so great slaughter, that the sea was stained with their blood for more than seven days. Theodore then consented to deliver up Dauforius, with 8000 crowns for the expences of the war; and Grimoald not only pardoned Dauforius, but received him into favour: the traitor, however, reflecting on the heinousness of his crime, was seized with remorse; and went a pilgrimage to the holy land, carrying a large stone in his mouth, by way of penance, which he never took out but at his meals.

In the year 821, Grimoald was murdered by Radelchis count of Confia, and Sico gassald of Acerenza, the latter of whom succeeded to the dukedom of Benevento. Radelchis being soon after seized with remorse, became a monk; while Sico associated his son Sicardo with him in the government; and both, being of an ambitious and restless disposition, sought a pretence for attacking the Neapolitans. This was

Frank.

5  
Grimoald continues for some time faithful to the Franks.

6  
Is murdered, and succeeded by Sico.

Naples.

7  
Naples be-  
sieged by  
Sico.

foen found, and the city was invested by sea and land. The walls were furiously battered; and part of them being beat down, Sico prepared for a general assault. Stephen, at that time duke of Naples, pretended to submit; but, that he might prevent the city from being pillaged, intreated Sico to put off his entry till the morning, and in the mean time sent out his mother and his two children as hostages. Sico consented to his request; and next morning found the breach built up, and the Neapolitans prepared for their defence. Exasperated at their perfidy, he renewed his attacks with vigour, but without any success; the besieged defending themselves with the utmost obstinacy. At last, perceiving that they should not be able to hold out much longer, they consented to a peace on the following conditions, viz. That the Neapolitans should pay an annual tribute to the princes of Benevento, and consent to the transporting of the body of St Januarius from his church without the walls of Naples to Benevento. These conditions being ratified, Sico returned with great honour to Benevento; but soon after renewed the war, under pretence that the Neapolitans had neglected to pay the stipulated sum; and hostilities continued till his death, which happened in 833.

8  
And by his  
successor  
Sicardo.

Sico was succeeded in the government of Benevento by his son Sicardo, who had married the daughter of Dauserius; and being influenced by the evil counsels of Rosfrid his wife's brother, oppressed his subjects to such a degree that they conspired against his life. He besieged Naples with a powerful army, and took possession of Acerra and Atella, both of which he fortified. But Bonus, the Neapolitan duke, defended himself so vigorously, that the Beneventans were obliged to retire, and even to abandon Acerra and Atella, the fortifications of which were immediately demolished. At last Sicardo agreed to a peace for five years, on the intercession of Lothaire, emperor and king of Italy; but his chief motive was thought to have been the fear of the Saracens, whom the duke of Naples had called over from Africa to his assistance: for no sooner were they sent back, than Sicardo attempted to delay the conclusion of the treaty; but the emperor interposing his authority, a peace was concluded in the year 836, after the war had continued, with very little intermission, for 16 years.

9  
The Saracens called  
in by the  
duke of  
Naples.

Soon after the conclusion of this peace, the Saracens landed at Brindisi; and having made themselves masters of the place, ravaged all the neighbouring country. Sicardo marched against them with a numerous army; but the Saracens having dug a great number of ditches which they slightly covered over, found means to draw the Beneventans in among them, whereby they were repulsed with great loss. However, Sicardo, having reinforced his army, marched again to attack them; but the Saracens, despairing of success, pillaged and burnt Brindisi, and then retired with their booty, and a great many captives, to Sicily. Sicardo then, without any apparent provocation, attacked the city of Amalfi, levelled its walls with the ground, carried off all its wealth, and the body of its tutelary saint Triphomen. A great many of the inhabitants were transported to Salerno; and by promoting alliances between the inhabitants of both places, he endeavoured to unite Amalfi to his own principality as

firmly as possible.

During all these transactions, Sicardo had tyrannized over his subjects in such a manner, that at last he became intolerable. Among other acts of injustice, he imprisoned his own brother Siconolphus; compelled him to turn priest; and afterwards sent him bound to Tarento, where he caused him to be shut up in an old tower that had been built for a cistern. By such acts of tyranny his nobles were provoked to conspire against him; and in the year 839 he was murdered in his tent.

Naples.

10  
Sicardo  
murdered  
by Radel-  
chis, which  
brings on a  
civil war.

On the death of Sicardo, Radelchis, his secretary or treasurer, was unanimously elected prince of Benevento; but Siconolphus, the last king's brother, having regained his liberty, formed a great party against the new prince. Radelchis did not fail to oppose him with a formidable army; and a most ruinous civil war ensued. Both parties by turns called in the Saracens; and these treacherous allies acted sometimes against one, and sometimes against the other; or turned their arms against both, as seemed most suitable to their own interest. Thus the war continued with the utmost animosity for 12 years, during which time the principality was almost entirely ruined; till at last the emperor Lewis interposed, and obliged the competitors to agree to a partition of the principality: by this treaty, Radelchis promised to acknowledge Siconolphus and his successors as lawful princes of the principality of Salerno, which was declared to contain Tarento, Latiniano, Cassano, Cosentino, Laino, Lucania, Confia, Montella, Rota, Salerno, Sarno, Ciraterium, Furculo, Capua, Feano, Sora, and the half of the Gastaldate of Acerenza, where it joins Latiniano and Confia. The boundary betwixt Benevento and Capua was fixed at St Angelo ad Cerros; Alli Peregrini was made the boundary betwixt Benevento and Salerno, and Staffilo betwixt Benevento and Confia. The monasteries of Monte Cassino and St Vincent were declared to be immediately under the protection of the emperor: both princes stipulated that no hostilities should be committed by either, against the subjects of each other; and promised to join their forces, in order to drive out the Saracens. Soon after this pacification, however, both Radelchis and Siconolphus died; the former appointing his son Radelgarius, or Radelcar, to succeed him; and the latter leaving an infant son, Sico, to the care of his godfather, Peter.

The war with the Saracens proved very unsuccessful; neither the united efforts of the princes, nor the assistance of the emperor Lewis himself, being able to expell the infidels; and in 854, Arechis, the son and successor of Radelchis, was obliged to pay them an annual subsidy. Two years after, Lando, count of Capua, revolted from the prince of Salerno, and could not be reduced. In the mean time, Sico, the lawful prince of Salerno, had been poisoned by count Lando, and the principality usurped by Ademarius, the son of Peter above-mentioned; but, in 861, Ademarius himself was seized and imprisoned by Guafarius, the son of Dauserius formerly mentioned. This was occasioned by his cruelty and rapaciousness, which entirely alienated the hearts of his subjects from him, and encouraged Guafarius to become the head of the conspirators. The Saracens in the mean time committed terrible

12  
Unsuccessful  
war  
with the  
Saracens.

Naples.

terrible ravages throughout the Beneventan territories which at last obliged Adelgife to enter into an alliance with Guafarius, and both together sent a most humble embassy to the emperor Lewis, requesting him to take them under his protection. About the same time an embassy arrived from Constantinople, proposing a junction of the forces of the eastern and western empires against the infidels; upon which Lewis gave orders for assembling a formidable army. But in the mean time Adelgife fell off from his alliance, and made peace with the Saracens; nay, according to some, he encouraged them in their incursions, and it was at his desire that they invaded the duchy of Capua, and afterwards that of Naples, which they ravaged in a most barbarous manner. The Neapolitans, in conjunction with the duke of Spoleto and the count of Marsi, endeavoured to oppose them; but being defeated, the Saracens continued their ravages with redoubled fury, and retired to Bari, which was their capital city, with an immense booty.

In 866, Lewis arrived at Sora with his army; and having marched to Capua, was there joined by Landolph, the bishop and count, with a body of Capuans: but Landolph soon after persuading his countrymen to desert, Lewis marched against that city, which he took after a siege of three months, and almost totally destroyed. In the end of the year he was joined by Guafarius with his quota of troops, having ordered the eyes of Ademarius to be put out in his absence. Lewis confirmed him in the principality, and marched with his army to Benevento, where Adelgife received him with great respect. Having reduced some inconsiderable places belonging to the Saracens, Lewis soon after invested Bari; but as the Saracens received continual supplies from their countrymen settled in Sicily, and besides were protected by the Neapolitans, he could not reduce the place till the year 871, tho' he had received considerable assistance from his brother Lotharius, and the Greek emperor had sent him a fleet of 200 sail. The expulsion of the Saracens was completed the same year by the taking of Tarento; after which the emperor returned with great glory to Benevento, resolving next to carry his arms into Sicily, and expel the infidels from thence also. But his future schemes of conquest were frustrated by a quarrel between him and Adelgife. The latter, pretending to have been insulted by the empress, and oppressed by the French, seized the emperor himself, and kept him prisoner for 40 days. His imprisonment would probably have been of much longer continuance, had not a body of Saracens arrived from Africa, who, being joined by such of their countrymen as had concealed themselves in Italy, laid siege to Salerno with an army of 30,000 men, ravaging the neighbouring country at the same time with the utmost barbarity. By this new invasion Adelgife was so much alarmed, that he set the emperor at liberty, but first obliged him to swear that he would not revenge the insult that had been offered him, and that he would never return to Benevento. Lewis having then joined his forces to those of the prince of Salerno, soon obliged the Saracens to raise the siege of Salerno; but tho' they were prevented from taking that city, they entirely destroyed the inhabitants of Calabria, leaving it, according to the expression of one of the historians of that time, "as

desolate as it was at the flood."

In the year 873, Lewis being absolved from his oath by the pope, went to Benevento, and was reconciled to Adelgife; but soon after this reconciliation he died, and the Saracens continued their ravages to such a degree that the inhabitants of Bari were constrained to deliver up their city to the Greeks. At the same time the Salernitans, Neapolitans, Cajetans, and Amalfitans, having made peace with the Saracens, were compelled to agree to their proposal of invading the territories of the Roman pontiff. His holiness exerted himself to the utmost, both with spiritual and temporal weapons, in order to defend his right; but was at last reduced to the necessity of becoming a tributary to the infidels, and promising to pay them a large sum annually.

<sup>15</sup>  
The pope becomes their tributary.

In the mean time all Italy was thrown into the greatest confusion by the death of Charles the Bald, who died of poison at Pavia, as he was coming to the pope's assistance. Sergius duke of Naples continued a firm friend to the infidels; nor could he be detached from their interests even by the thunder of a papal excommunication: but unluckily happening to fall into the hands of his brother Athanasius bishop of Naples, the zeal of that prelate prompted him to put out his eyes, and send him a close prisoner to Rome; for which the highest encomiums were bestowed on him by the holy father.

In 878, Adelgife was murdered by two of his nephews; one of whom, by name *Gaidaris*, seized the principality. About the same time Landolph bishop of Capua dying, a civil war ensued among his children, though their father's dominions had been divided among them according to his will. The princes of Salerno and Benevento, the duke of Spoleto, and Gregory the Greek governor of Bari and Otranto, took different sides in the quarrel, as they thought most proper; and to complete the confusion, the new bishop was expelled, and his brother, though a layman, chosen to that office, and even consecrated by the pope, who wrote to Guafarius, forbidding him to attack Capua under pain of excommunication. But though Guafarius was, in general, obedient to the pope's commands, he proved refractory in this particular, and laid siege to Capua for two years successively.

Thus the Capuan territories were reduced to the most miserable situation; being obliged to maintain at the same time the armies of the prince of Benevento and the duke of Spoleto. The Saracens in the mean time took the opportunity of strengthening themselves in Italy; and Athanasius, notwithstanding the great communications he had received from the pope for putting out his brother's eyes, consented to enter into an alliance with them, in conjunction with whom he ravaged the territories of the pope, as well as those of Benevento and Spoleto, plundering all the churches, monasteries, towns, and villages, through which they passed. At the same time the prince of Salerno was obliged to grant them a settlement in the neighbourhood of his capital; the duke of Geta invited them to his assistance, being oppressed by the count of Capua; and even the pope himself was obliged to make peace with them, and to grant them a settlement on the north side of the Garigliano, where they fortified themselves, and continued for more than 40 years.

To

<sup>13</sup>  
They are at last expelled.

<sup>14</sup>  
But soon return.

Naples.

To put a stop to the confusion which reigned in Italy, the pope now thought proper to restore the bishop of Capua, who had been expelled, but allowed his brother to reside in the city, and govern one half of the diocese; but notwithstanding this partition, the civil dissensions continued with the utmost violence, the nearest relations murdering or banishing each other, according as the fortune of the one or the other prevailed.—Athanasius, notwithstanding all the pope's remonstrances, continued his alliance with the Saracens; in conjunction with whom he ravaged the territory of Benevento, and fomented the divisions in Capua, in hopes of being able to make a conquest of it. At last his holiness thought proper to issue a sentence of excommunication against him: but this attached him to the Saracens more than ever; inasmuch that he sent to Suchaim, king of the Saracens in Sicily, desiring him to come over and command a great body of his countrymen who had settled at the foot of Mount Veluvius. Suchaim accepted the invitation, and immediately turned his arms against Athanasius; allowing his troops to live at discretion in the territory of Naples, where they ravished the women, and plundered the inhabitants. These calamities were, by the superstitious Neapolitans, imagined to be a consequence of the sentence of excommunication; and therefore they used their utmost endeavours to persuade the prelate to conclude a league with some Christian prince, and renounce all connection with the infidels. In this they at last proved successful, and Athanasius concluded an alliance with Guaimarius prince of Salerno; in consequence of which the Saracens were obliged to quit the Neapolitan territories, and retire to Agropoli. Athanasius then directed his force against Capua, of which he made himself master in the year 882. The Saracens, however, still continued their incursions, and ravaged several provinces in such a manner, that they became entirely desolate.

These confusions continued for a long time; during which the Greeks found an opportunity of making themselves masters of Benevento, and had well nigh become masters also of Salerno; but in this they failed through the treachery of the bishop, and in the year 896 they were totally expelled by the bishop, four years after they had become masters of it. In 915 the Saracens received such an overthrow at Carigliano, that scarce one of them remained; however, a new body soon arrived from Africa, and infested the sea-coasts for some time longer. A war also ensued between Landulph and the Greeks; which concluded disadvantageously for the former, who was obliged to submit to the emperor of Constantinople in 943.

In 961, Otho the Great, king of Germany, invaded Italy with a powerful army against Berengarius III. and, marching to Rome, received the imperial crown from the hands of the pope. In 964, he erected Capua into a principality, received homage from the other princes of Lombardy, and formed a design of recovering Puglia and Calabria from the Greeks. But in this last scheme he failed; and after various hostilities a treaty was concluded, and the young princess Theophania married to Otho's son, afterwards emperor.

All this time the Saracens continued their incursions; and the Greeks had gained ground so much,

that they were now in possession of two thirds of the present kingdom of Naples; but in the year 1002 or 1003, the Normans first began to be remarkable in Italy. They had, about a century before, embraced Christianity, and become very zealous in all the superstitions which were then practised. They were particularly zealous in visiting sacred places, especially Rome, and the holy sepulchre at Jerusalem; and being naturally of a very martial disposition, they forced through great bodies of Greeks and Saracens who opposed their passage. About this time, 40, or, as others write, 100, of these Normans, returning from Jerusalem by sea, landed at Salerno in the habit of pilgrims, where they were honourably received by Guaimarius. During their residence at Salerno, a great body of Saracens landed, and invested the city. Guaimarius, not being in a condition to oppose the invaders by force, was preparing to pay them a large sum of money which they demanded, when the Normans proposed to attack them; and, having got arms and horses from the prince, they engaged the infidels with such fury and bravery, that they entirely defeated them, and obliged them to fly to their ships. By this complete victory Guaimarius was filled with such admiration of the valour of these strangers, that he treated them to remain in his country; offering them lands, and the most honourable employments; but not being able to prevail with them to stay in Italy, or even accept of his presents; at their departure he sent some ambassadors with them to Normandy, in vessels loaded with exquisite fruits, rich furniture for horses, &c. in order to allure the valiant Normans to leave their own country. This kind invitation encouraged a Norman chief, named *Osmond Drengot*, to settle in Italy about the year 1015; having killed another lord in a duel, which obliged him to leave his own country, in order to avoid the resentment of his sovereign, Robert duke of Normandy. In the mean time the city of Bari had revolted from the Greeks, and chosen one Mello for their leader, whose wife and children happened soon after to fall into the hands of their enemies, and were sent prisoners to Constantinople. No sooner, therefore, did Mello hear of the arrival of these adventurers, than he engaged them to assist him, and having drawn together a considerable army, defeated the Greeks with great slaughter, and obliged them to abandon their camp. In this engagement the Normans distinguished themselves by their bravery; and the news of their success soon brought from Normandy an innumerable multitude of their countrymen, with their wives and children. By this reinforcement, Mello gained two other victories, took a great many towns, and obliged the Greeks to abandon a large territory; but, in 1019 they were utterly defeated, and every thing recovered by the Greeks. The Greek general, Ebanus, continued to go on with such surprising success, that he almost entirely re-established the affairs of his countrymen in Italy, and made a distinct province of the western part of Puglia, which he called *Capitanata*, and which to this day retains the name of *Capitanata*. His great progress at last alarmed the emperors of Germany; and, in 1027, Pandulphus prince of Capua made himself master of Naples; but was obliged, three years afterwards, to leave it, by the Normans, who built the

Naples.

17  
The Normans first known in Italy.

16  
The Saracens almost entirely cut off.

18  
They return and defeat the Greeks.

19  
But are at last defeated by them.



Naples.

city of Averfa, which was now erected into a county. In confequence of this piece of good fortune, great numbers of Norman adventurers migrated into Italy; among whom were William, Drogo, and Umbert, three of the fons of Tancred duke of Hautville; from whose pofterity thofe princes were defended, who firft conquered the Ifland of Sicily from the Saracens, and formed the prefent kingdom of Naples.

In 1040, the Greek emperor Michael Paleologus, in order to fecure the affection of his fickie fubjects, undertook the conqueft of Italy from the Saracens, and for that purpofe fent a general named *Michael Maniacus* into Sicily. This commander, hearing of the great reputation of the Normans, fent to Guimarius, prince of Salerno, intreating him to grant him fome of thofe warriors. His request was moft willingly hearkened to by the prince of Salerno, who, to encourage the Normans to engage in the expedition, promifed them fome additional rewards befides the emperor's pay. William, Drogo, and Umbert, accordingly marched from Salerno with 300 of their countrymen; and paffing over into Sicily, diftinguifhed themfelves moft remarkably in the conqueft of that ifland. Maniacus acknowledged, that the recovery of Melfina was chiefly owing to their valour; and William with his Normans gained a complete victory over the Saracens before Syracufe, where he killed the governor of the city in fingle combat. Maniacus made himfelf matter of Syracufe, and almoft entirely reduced the whole ifland; but, being accufed of treafon, was next year carried prifoner to Conftantinople. His fucceffor Doceanus, being a man of no abilities, quickly loft the whole ifland except Melfina, and treated his Norman auxiliaries with the utmoft contempt. He would not allow them any fhare of the booty; and even caufed one Ardoin, a noble Lombard, and affociate and interpreter of the Normans, to be whipped round the camp, becaufe he refufed to part with the horfe of a Saracen whom he had flain in fingle combat. The confequences of this tyrannical behaviour were very fatal to the Greeks. Ardoin foon after obtained leave to return to Italy under pretence of a vow, and all the Normans embarked at night along with him; but inftead of going to Rome, Ardoin went immediately to Averfa, where he perfuaded count Rainulphus, fovereign of that province, to join with him in the defign he had formed of attacking the Greek provinces in Italy, which, he fhewed him, would be an eafy conqueft, as the inhabitants fubmitted with great reluctance to the Greeks, and the provinces were at that time almoft entirely defencelefs. Rainulphus approved of the fcheme, and raifed 300 foldiers, whom he fent under 12 officers, to join the other Normans under the fons of Tancred; and made an agreement with Ardoin, that the conquefts fhould be equally divided among the chief leaders. Their firft enterprife was the reduction of Melfina, one of the ftrongeft cities in Puglia, which prefently furrendered; and they increafed its fortifications fo much, that it thenceforth became impregnable. Soon after this they made themfelves mafters of Venofa, Afcoli, and Lavello, with very little oppofition. Doceanus alarmed with the rapidity of their conquefts, immediately left Sicily, and marched with his army into Puglia, where he attacked the invaders near the river Olivinto; but, after a fierce engagement, he

was obliged to retire with confiderable lofs. The Greeks were foon after defeated a fecond time at Canne; and in a third engagement, which happened near the river Ofanto, the army of Doceanus was entirely routed, and he himfelf obliged to fly to Bari. On this bad fuccefs Doceanus was ordered to return to his command in Sicily, and another general was fent with an army into Puglia. This new commander, however, had no better fuccefs than his predecessor; for his army was entirely defeated in an engagement with the Normans, and he himfelf taken prifoner. Atenulphus, brother to one of the princes of Benevento, on whom the Normans had conferred the chief command, fet at liberty the captive general without confulting them, on receiving from him a confiderable fum of money. With this the Normans were fo much difpleafed, that they deprived Atenulphus of his command, and beftowed it on Argyrus fon to the late Mello, who had efaped from Conftantinople, and now affumed the title of *duke and prince of Italy*. Before this time alfo Maniacus, whom we have formerly mentioned, had returned to Italy; and to ftrike the greater terror into the revolted cities, had executed a number of people of all ages and fexes with great inhumanity. Soon after this Maniacus openly rebelled againft the Greek emperor Conftantinus, and prevailed upon his own army to proclaim him emperor, beginning hoftilities immediately againft the Greek cities. Argyrus at the fame time took Giovannazzo and befieged Trani, and foon after befieged Maniacus himfelf in Tarento; but he, being afraid of falling into the hands of the Normans, fled to Otranto, and from thence to Bulgaria, where, being entirely defeated by one of the emperor's generals, he was taken prifoner, and had his head ftruck off.

The Normans having now conquered the greateft part of Puglia, proceeded to make a divifion of their conqueft; in which, after each commander had got his proper fhare, the city of Melfis was left common to all, and appropriated as a place for afsembling to confult about the moft important affairs of the nation. Argyrus alone was neglected in this divifion; but he, having gained the favour of the emperor by expelling the rebel Maniacus from Italy, was by him created duke of Bari, on purpofe to check the power of the Normans, with the title of *prince and duke of Puglia*. The Normans, however were too powerful to be much awed by Argyrus, and behaved with great infolence to the neighbouring princes; but as they could not be expelled by force, and were confirmed in their conquefts by Henry II. emperor of Germany in 1047, the Greek emperor attempted to get rid of them, by fending Argyrus with large fums of money to bribe them to enter into his fervice againft the Perfians. But they, perceiving the snare, replied, that they were refolved not to leave Italy unlefs they were expelled by force; upon which Argyrus made ufe of the fame money in bribing the Puglians to affaffinate thefe invaders. This brought on a mafacre, in which greater numbers of Normans perifhed than had fallen in all the late wars. Argyrus attempted to take advantage of the confufion produced by this mafacre, but was defeated; after which he had recourfe to Pope Leo, befecching him to deliver Italy from thefe cruel tyrants; but this fcheme proved ftill more unlucefful than the others had been; for

20  
The Normans pafs over into Sicily.

21  
Their conquefts.

22  
Great numbers of them mafacred.

Naples.

33  
They are  
conquered by  
the pope  
in all their  
conquests.

for the pope himself was defeated and taken prisoner, and, in consequence of the respect shewed him by the Normans, granted them, as a fief of the holy see, all the conquests they had made or should make in Calabria and Sicily.

Soon after this, the Norman power became extremely formidable; the famous Robert Guiscard ascended the throne in 1056. He made great progress in the conquest of Calabria, and reduced most of the cities which held for the Greeks in these parts. About the same time the counts of Capua were expelled from their territory; and the abbot Desiderius mentions his having seen the children of Landolphus V. the last count, going about as vagabonds, and begging for their support. The pope, alarmed by these conquests, excommunicated the Normans in wholesale, pretending that they had seized some of the territories belonging to the church; but, by the pretended submission of Robert, he not only was persuaded to take off the sentence of excommunication, but to invest him with the provinces of Apulia, Calabria, and Sicily. After this, he continued the war against the Greeks with great success. In 1071, in conjunction with his brother Roger, he conquered the island of Sicily, and gave the investiture of the whole island to him with the title of *count*, reserving to himself only the half of Palermo, Messina, and the valley of Demona. The like success attended his arms against Salerno in 1074; but after this, having unadvisedly taken some places from the pope, he again fell under the sentence of excommunication; yet he was reconciled to him in 1080, and received a second time the investiture of all his dominions. The next year he undertook an expedition against the Greeks; and though the emperor was assisted by a Venetian fleet, Robert made himself master of the island of Corfu, reduced Durazzo, and great part of Romania; inasmuch that by the success of his arms, and his near approach to Constantinople, he struck an universal terror among the Greeks. But while Robert was thus extending his conquests, he was alarmed by the news of a formidable rebellion in Italy, and that the emperor Henry had taken the city of Rome, and closely shut up the pope in the castle of St Angelo. Robert therefore, leaving the command of the army to his son Boemund, returned to Italy, where he immediately dispersed the rebels, and released the pope, while his son gained a considerable victory over the Greeks. After this Robert made great preparations for another expedition into Greece, in order to second his son Boemund. Alexius, being assisted by the Venetian fleet, endeavoured to oppose his passage; but was entirely defeated, with the loss of a great many galleys. But a final stop was now put to his enterprises by his death, which happened in the island of Corfu in 1085.

Tho' the power of the Normans was thus thoroughly established in Italy and Sicily; yet by reason of the civil dissensions which took place among themselves, and the general confusion which reigned in Italy in their valour, to submit to the emperor in 1195. By him the Sicilians were treated with so great cruelty, that the empress Constantia was induced to conspire against him in 1197, took him prisoner, and released him only on condition of his sending off his

34  
Sicily con-  
quered by  
Robert  
Guiscard.

35  
And by the  
emperor of  
Germany.

army immediately for the Holy Land. This was complied with; but the emperor did not long survive the reconciliation, being poisoned, as was supposed, by order of the empress.

In 1254 the pope claimed the kingdom as a fief devolved on the church in consequence of a sentence of deposition pronounced against king Frederic at the council of Lyons; and, in 1263, the kingdom was, in consequence of this right, conferred on Charles count of Anjou. After much contention and bloodshed, the French thus became masters of Sicily and Naples. Their government was insupportably tyrannical; and at the same time the haughtiness of their king provoked the pope, that he resolved to humble him. Charles had resolved on an expedition against Constan-

36  
The French  
become  
masters of  
Sicily and  
Naples.

tinople; and for this purpose had fitted out a fleet of 100 galleys, 30 large ships, 200 transports, besides many other smaller vessels, on board of which he intended to embark 10,000 horse, and a numerous army of foot.—This formidable armament greatly alarmed the emperor Michael Paleologus; for which reason he entered into a negotiation with John di Procida, a noble Selernitan, lord of the isle of Procida in the bay of Naples, who had formed a scheme for a general revolt in the Island of Sicily. John, though a nobleman, was also a physician, and had been counsellor to two former princes, and even to king Charles himself; but being stripped of his estate by the king under pretence of treason, and his wife being debauched by the French, he retired to Constantia queen of Arragon, where he was created a baron of the kingdom of Valencia, by her husband king Peter, and Lord of Luxen, Benizzano, and Palma. As he was greatly exasperated against the French, he employed many spies both in Puglia and Sicily; and being informed that the Sicilians were totally disaffected to the French, he came to the island in disguise, and concerted a plan with the most powerful of the malcontents for a revolution in favour of Constantia, though he derived her right only as being the daughter of a former usurper named *Manfred*. Procida then set out for Constantinople, where, in some private conferences with the emperor, he persuaded him, that the most probable means of defeating Charles's scheme was by assisting the Spaniards and Sicilian malcontents. Paleologus accordingly granted him a large sum of money, and on his departure sent one of his secretaries along with him, who, landing in Sicily, had a conference with the chief conspirator. John, having received letters from them, disguised himself in the habit of a Franciscan, and went to Suriano in the neighbourhood of Rome. As he well knew the enmity which subsisted between the pope and king Charles, he disclosed his design to his holiness; who readily entered into his measures, wrote to Peter to hasten his armament, promising him the investiture of the island as soon as he had taken possession of it; and, by refusing the assistance he had promised to Charles, obliged him for the present to delay his expedition. In the beginning of the year 1280, Procida returned to Arragon; and by shewing the letters from the pope and Sicilian barons, prevailed on Peter to embark in his design, by assuring him of the assistance of Paleologus. The king of Arragon accordingly prepared a formidable fleet under pretence of invading Africa, and is even said to have received 20,000 ducats

cate

cats from Charles in order to assist him in his preparations.

But while John went on thus successfully with his scheme, all his measures were in danger of being broke by the death of pope Nicholas. The new pope, Martin IV, was entirely in the interest of Charles, on whom, in 1281, he conferred the senatorial dignity of Rome. Prociada, however, still resolved to prosecute his scheme; and, leaving Italy, had another conference with the conspirators in Sicily; after which, he again went to Constantinople, and obtained from Paleologus 30,000 ounces of gold, with which he immediately returned to Arragon. The death of Nicholas had damped the ardour of Peter; but, being urged with great earnestness by John, he again renewed his preparations; which alarmed the pope and the king of France. In consequence of this they sent a message to him, desiring to know against what Saracens he designed to employ his armament. In this particular Peter refused to satisfy them; upon which they earnestly counselled Charles to guard against an invasion; but he neglected their advice, being wholly intent on his eastern expedition, and encouraged by a revolt which had happened in Greece; and to facilitate his expedition, he prevailed on the pope to excommunicate the Greeks, on pretence that they had broken some of the articles of union concluded at the council of Lyons a few years before. Peter in the mean time continued his preparations with great diligence; intending to put to sea the following summer. Prociada had returned to Palermo, to wait for a favourable opportunity of putting his design in execution, which was soon afforded him by the French. On Easter Monday, March 30th, 1282, the chief conspirators had assembled at Palermo; and, after dinner, both the Palermitans and French went in a grand procession to the church of Monreale, about three miles without the city. While they were sporting in the fields, a bride happened to pass by with her train; who being observed by one Drochettus, a Frenchman, he ran to her, and began to use her in a rude manner, under pretence of searching for concealed arms. A young Sicilian, exasperated at this affront, stabbed him with his own sword; and a tumult ensuing, 200 French were immediately murdered. The enraged populace then ran to the city, crying out "Let the French die, Let the French die;" and, without distinction of sex or age, slaughtered all of that nation they could find, even such as had fled to the churches. The conspirators then left Palermo, and excited the inhabitants to murder the French all over the island, excepting in Messina, which city at first refused to be concerned in the revolt. But, being invited by the Palermitans to throw off the French yoke, a few weeks after, the citizens in a tumultuous manner destroyed some of the French; and pulling down the arms of king Charles, and erecting those of the city, chose one Baldwin for their governor, who saved the remaining French from the fury of the populace, and allowed them to transport themselves, with their wives and children, to Italy. Eight thousand persons are said to have been murdered on this occasion.

Immediately after this massacre, the Sicilians offered their allegiance to the king of Arragon; who accepted of the invitation, and landed with his forces at Trapani. From thence he went to Palermo, where he was

crowned king of Sicily with great solemnity, and Charles left the island with precipitation. The day after he landed his army in Italy, the Arragonian fleet arrived, took 29 of his galleys, and the next day burnt 80 transports in presence of his army. Soon after this Charles sent an embassy to Peter, accusing him of perfidy, in invading his dominions in time of peace; and, according to some, challenged him at the same time to decide the matter by single combat. Others say, that the challenge was given by Peter. Certain it is, however, that a challenge was given, and to appearance accepted; but Peter determined to employ much more effectual means in support of his pretensions than trusting to a duel; and therefore pushed on his operations most vigorously, while his adversary trifled away his time: and thus he at last became master of the contended kingdom; which, however, he did not long enjoy, dying about the end of the year 1285.

By his will, Peter left the kingdom of Arragon to his eldest son Alphonus, and Sicily to Don James his other son, who was also to succeed to the kingdom of Arragon in case Alphonus should die without male issue. Accordingly, Don James was solemnly crowned at Palermo the 2d of February 1286. In 1205, however, he deserted them, and tamely resigned up his right to Charles, son to him above-mentioned, in a manner perhaps unparalleled. On his resignation the Sicilians conferred the crown upon his brother Don Frederic: after which the war continued with great violence till the year 1303, when a peace was concluded, and the kingdoms of Naples and Sicily formally disjoined; Frederic being allowed to keep the latter, under the name of *Trinacria*, and Charles being confirmed in the possession of the former, which he quietly enjoyed till his death in 1309.

Naples continued to be governed by its own kings till the beginning of the 16th century, when the kings of France and Spain contended for the sovereignty of this country. Frederic, at that time king of Naples, resigned the sovereignty to Lewis XII. on being created duke of Anjou, and receiving an annual pension of 30,000 ducats. But, in 1504, the French were entirely defeated by the Spaniards, and obliged to evacuate the kingdom; and the following year Lewis renounced all pretensions to the crown, which from that time hath remained almost constantly in the hands of the Spaniards.

The government of the Spaniards proved no less oppressive to the Neapolitans than that of others had been. The kings of Spain set no bounds to their exactions, and of consequence the people were loaded with all manner of taxes; even the most indispensable necessities of life not being exempted. In 1647, a new tax was laid on fruit; which the people looked upon as the most grievous oppression; the chief part of their subsistence, during the summer-months, being fruit, which in the kingdom of Naples is very plentiful and delicious. The edict for collecting the new duty was no sooner published, than the people began to murmur in a tumultuous manner; and when the viceroys came abroad, they surrounded his coach, bawling out to have their grievances redressed. They were encouraged in their sedition, by the news that the citizens of Palermo had actually revolted on account of the imposition of new duties. The viceroy therefore, apprehensive

Naples.

28  
The kingdoms of Naples and Sicily disjoined.

29  
The Spaniards became masters of Naples.

30  
A general revolt.

27  
they are massacred.

Naples.

henfive of greater diforders, began to think of taking off the tax; but thofe who farmed the tax having bribed fome of his favourites, he was by their means perfwaded not to abolifh it. The indignation of the people, who had fufpected his intention, was now greatly increafed; efpecially as they were privately excited by feveral malcontents. The farmers of the revenue, and all thofe concerned in raifing the taxes, had incurred the hatred and deteftation of the people, particularly of Tommafo Aniello, commonly called *Maffaniello* of *Amalfi*, a fifherman, whofe wife, having been difcovered in fmggling a fmall quantity of meal, was imprifoned, and condemned to pay a fine of 100 ducats.

Maffaniello, a few years before, had come to Naples from Amalfi, where his father had been a fifherman. At this time he was about 24 years of age, and the father of four children. He was of a middling ftature, and an agreeable afpect; was diftinguifhed for his boldnefs, activity, and integrity; and had a great influence with his companions, by whom he was beloved and efteemed. As he was obliged even to fell his furniture to pay the heavy fine, he had conceived an implacable hatred againft the farmers of the taxes, and was alfo moved with compaffion for the miserable ftate of the city and kingdom. He therefore formed a defign, with fome of his companions, to raife a tumult in the market-place on the feftival-day of the Carmelites, ufually celebrated about the middle of July, when between 500 and 600 youths entertain the people by a mock-fight; one half of them in the character of Turks, defending a wooden-caftle, which is attacked and ftormed by the other half in the character of Chriftians. Maffaniello being appointed captain of one of thefe parties, and one Pione, who was privy to his defign, commanding the other, for feveral weeks before the feftival they were very diligent in reviewing and training their followers, who were armed with flicks and reeds: but a fmall and unforefeen accident, tempted them to begin their enterprife without waiting for the feftival.

On the 7th of July a difpute happening in the market-place betwixt the tax-gatherers and fome gardeners of Pozzuolo who had brought fome figs into the city, whether the buyer or feller fhould pay the duty; after the tumult had continued feveral hours, Maffaniello, who was prefent with his company, excited the mob to pillage the office built in the market for receiving the duty, and to drive away the officers with ftones. The elect of the people, who, by deciding againft the gardeners, had increafed the tumult, run to the palace, and informed the viceroy, who moft imprudently neglected all means of putting a flop to the commotion. Maffaniello, in the mean time, being joined by great numbers of people, ordered his young troop to fet fire to all the offices for the taxes through the city; which command being executed with difpatch, he then conducted them directly to the palace, where the viceroy, inftead of ordering his Spanifh and German guards to difperfe them, encouraged their intolence by timidly granting their demands. As they rufhed into the palace in a furious manner, he efcaped by a private door, and endeavoured to fave himfelf in *Caftel del Ovo*; but being overtaken by the rioters in the ftreets, he was trampled upon by them, and pulled by the hair and whifkers. However, by throwing fome

Naples.

handfuls of gold among them, he again efcaped, and took fanctuary in a convent of Minims, where, being joined by the archbifhop of Naples, cardinal Filomarini, and feveral nobles, by their advice he figned a billet, by which he abolifhed all taxes upon provifions. As a means to quell the tumult, he likewife defired the cardinal to offer Maffaniello a penfion of 2400 crowns, who generoufly rejected the bribe; and declared, that if the viceroy would keep his word, he would find them obedient fubjects.

It was now expected that the tumult would ceafe: but Maffaniello, upon his return to the market-place, being joined by feveral malcontents, among whom were Genuino and one Peronne, who had formerly been a captain of the Sbirri, he was advifed by them to order the houfes of thofe concerned in raifing the tax to be burned; which were accordingly in a few days reduced to afhes, with all their rich furniture. Maffaniello being now abfolute mafter of the whole city, and being joined by great numbers of people of defperate fortunes, he required the viceroy, who had retired to the *Caftel Nuovo*, to abolifh all the taxes, and to deliver up the writ of exemption granted by Charles V. This new demand greatly embarrassed the viceroy; but to appeafe the people, he drew up a falfe deed in letters of gold, and lent it to them by their favourite the duke of Matalone, who had before been in confinement. The fraud, however, being difcovered, the duke was pulled from his horfe and maltreated by the mob, and at length committed as a prifoner to Peronne. This accident, to the great joy of the viceroy, enraged the people againft the nobility, feveral of whom they killed, burnt the houfes of others, and threatened to extirpate them all. Maffaniello, in the mean time, tattered and half naked, commanded his followers, who were now well armed, and were reckoned about 100,000 men, with a moft abfolute fway. He eat and fleep little, gave his orders with great precifion and judgment, appeared full of moderation, without ambition and interefted views. But the duke of Matalone having procured his liberty by bribing Peronne, the viceroy imitated his example, and fecretly corrupted Genuino to betray his chief. A confpiracy was accordingly formed againft Maffaniello by Matalone and Peronne; the duke, who was equally exasperated againft the viceroy, propofing, that after his death his brother D. Jofeph fhould head the rebels.

Maffaniello in the mean time, by means of the cardinal archbifhop, was negotiating a general peace and accommodation; but while both parties were afsembling in the convent of the Carmelites, the banditti hired by Matalone made an unfeccful attempt upon Maffaniello's life. His followers immediately killed 150 of them. Peronne and D. Jofeph being difcovered to be concerned in the confpiracy, were likewife put to death, and the duke with great difficulty efcaped. Maffaniello by this confpiracy was rendered more fufpicious and fevere. He began to abufe his power by putting feveral perfons to death upon flight pretences; and, to force the viceroy to an accommodation, he cut off all communication with the caftles, which were unprovided with provifion and ammunition. The viceroy likewife being afraid left the French fhould take advantage of the commotion, earneftly defired to agree to a treaty; which was accordingly concluded

Naples.

on the fifth day of the insurrection, by the mediation of the archbishop. By the treaty it was stipulated, that all duties imposed since the time of Charles V. should be abolished; that the writ of exemption granted by that emperor should be delivered to the people; that for the future no new taxes should be imposed; that the vote of the elect of the people should be equal to the votes of the nobility; that an act of oblivion should be granted for all that was past; and that the people should continue in arms under Maffaniello till the ratification of the treaty by the king.

By this treaty, no less than 10,000 persons, who fattened upon the blood of the public, were ruined. The people, when it was solemnly published, manifested an extreme joy, believing they had now recovered all their ancient rights and privileges. Maffaniello, at the desire of the viceroy, went to the palace to visit him, accompanied by the archbishop, who was obliged to threaten him with excommunication, before he would consent to lay aside his rags and assume a magnificent dress. He was received by the duke with the greatest demonstrations of respect and friendship, while the duchess entertained his wife, and presented her with a robe of cloth of silver, and some jewels. The viceroy, to preserve some shadow of authority, appointed him captain-general; and at his departure made him a present of a golden chain of great value, which with great difficulty he was prevailed upon to accept; but yielded at length to the intreaties of the cardinal. Next day, in consequence of the commission granted him by the viceroy, he began to exercise all the functions of sovereign authority; and having caused a scaffold to be erected in one of the streets, and several gibbets, he judged all crimes, whether civil or military, in the last resort; and ordered the guilty to be immediately put to death, which was the punishment he assigned to all offences. Though he neglected all forms of law, and even frequently judged by physiognomy, yet he is said not to have overlooked any criminal, or punished any innocent person.

His grandeur and prosperity was of very short continuance: for his mind becoming distracted and delirious for two or three days, he committed a great many mad and extravagant actions; and on the 18th of July was assassinated with the consent of the viceroy.

The tumult did not end with the death of Maffaniello: on the contrary, the people now expelled the Spaniards from most of the cities throughout the kingdom; and this general insurrection being the subject of discourse at Rome, the duke of Guise, who happened then to be at the pope's court, took the opportunity, at the instigation of his holiness, to offer his service to the Neapolitans against the Spaniards. The duke was prompted by his ambition to engage in this enterprize, especially as he himself had some distant pretensions to the crown. The Spaniards in the mean time made a vigorous attack on the city; but were repulsed by the people, who now formally renounced their allegiance to them. In a short time, however, their city being surpris'd by the new viceroy the count d'Oniate, and the duke of Guise himself taken prisoners, the people returned to their allegiance; and thus all the attempts of the French on Naples were frustrated. Since that time the Spaniards continued in peaceable possession of the kingdom till the year 1707, when

Vol. VII.

2

it was taken from them by prince Eugene. It was formally ceded to the emperor by the treaty of Rastadt in 1713; but was recovered by the Spaniards in 1734, and the king of Spain's eldest son is now the king of Naples and Sicily. For a particular account of these revolutions, see the articles SPAIN and SICILY.

The climate of Naples is extremely hot, especially in July, August, and September. In winter there is seldom any ice or snow, except on the mountains. On account of its fertility, it is justly termed an earthly paradise; for it abounds with all sorts of grain, the finest fruit and garden-productions of every kind, with rice, flax, oil, and wine, in the greatest plenty and perfection. It affords also fasson, manna, alum, vitriol, sulphur, rock-crystal, marble, and several sorts of minerals, together with fine wool, and silk. The horses of this country are famous, and the flocks and herds very numerous. Besides these products, of which a considerable part is exported, there are manufactures of fluff, soap, and glass-ware. Waistcoats, caps, stockings, and gloves, are also made of the hair or filaments of a shell-fish, which are warmer than those of wool, and of a beautiful glossy green. In this kingdom likewise is found that called the *Phrygian stone*, or *pietra fungifera*, which, being laid in a damp shady place, will yield mushrooms, sometimes of a very large size, especially if the stone is sprinkled with hot water. See AGARICUS.

As to the mountains of this country, the principal are those of the Apennine, which traverse it from south to north; and Mount Vesuvius, which, as is well known, is a noted volcano, five Italian miles from Naples. The side of this mountain next the sea yields wine, particularly the two famed wines called *Vino Greco* and *Lachrymæ Christi*. One of the greatest inconveniencies to which this kingdom is exposed is earthquakes, which the eruptions of Mount Vesuvius contribute, in some measure, to prevent. Another inconveniency, which, however, is common to it with other hot countries, is the great number of reptiles and insects, of which some are very poisonous.

With respect to religion, it is on a very bad footing here. The number of convents and monasteries is astonishing. It is said, the clergy and convents possess two-thirds of the whole kingdom: nay, some maintain, that were the kingdom divided into five parts, four would be found in the hands of the church. Notwithstanding this power and influence of the clergy, they have not been able hitherto to get the inquisition established here. In the year 1731, measures were taken for lessening the number of convents; and, lately, the order of Jesuits hath been suppressed. The papal bulls cannot be made public without the king's permission; nor are protestants compelled to kneel in the churches, or at the meeting the host; and in Lent they can very easily procure flesh-meat. In the year 1740, the Jews were allowed to settle in the kingdom, during the term of 50 years, and several privileges were granted them during that period; at the expiration of which, the grant was to be supposed to be renewed, unless they were expressly ordered to quit the country.

The revenue of the kingdom is generally computed at 3,000,000 of crowns; but, as Mr Addison observes, there is no country in Europe which pays a greater

29 Y

greater

32  
A treaty concluded between Maffaniello and the viceroy.

33  
Maffaniello appointed captain-general.

34  
Is assassinated.

35  
The people return to their allegiance.

Naples.

36  
Climate, produce, &c. of Naples.

37  
R. Ligon.

38  
Revenue, &c.

Naples. greater taxes, and where, at the same time, the public is less the better for them, most of them going to the enriching of the private persons to whom they are mortgaged.

The military force of this kingdom is said to consist of about 30,000 men, of which the Swiss regiments are the best. As to the marine, it consists only of a few galleys. The only order here is that of St Januarius, which was instituted by Don Carlos, in the year 1758.

The king of Naples, or of the two Sicilies, is an hereditary monarch. The high colleges are the council of state, the privy-council, the treasury, the Sicily-council, the council of war, &c. This kingdom is a papal fief; and the king, in acknowledgment of the pope's feudal right, sends him every year a white palfrey, and a purse of 6000 ducats. The title of the king's eldest son is *prince of Calabria*. The number both of the high and low nobility in the kingdom of Naples is very great; but their incomes in general are very slender. The higher nobles consist of princes, dukes, marquises, and barons. The general assembly of the states, consisting of the nobility and commons, is summoned, every two years, to meet at the capital, to deliberate on the customary free gift to the crown.

The inhabitants of this country bear but an indifferent character among other nations; but if they are really as defective in this respect as they are represented, it is undoubtedly, in some measure at least, owing to the oppression and slavery under which they groan, both from their civil and ecclesiastical governors. The kingdom is divided into twelve provinces or jurisdictions.

NAPLES, anciently *Parthenope*, afterwards *Neapolis*, the capital of the kingdom of that name in Italy, lying in the province called *Terra di Lavora*, which is the richest and best inhabited of the whole kingdom, and comprehends a part of the ancient Campania Felix, or the Happy. This city is said to be the first for strength and neatness, and the third for bigness, in all Italy. It is most advantageously situated, having a delicious country on one side, and a noble bay of the Mediterranean on the other, with an excellent harbour. The circumference, including the suburbs, is said not to be less than 18 Italian miles, and the number of the inhabitants therein above 400,000. The houses are of stone, flat-roofed, and generally lofty and uniform; but many of them have balconies, with lattice-windows. The streets are well paved; but they are not lighted at night, and in the day-time are disfigured, in many places, by stalls, on which provisions are exposed to sale. Here are a great number of fine churches, convents, fountains, and palaces of the nobility, many of whom constantly reside here. It is usual to walk on the tops of the houses in the evenings, to breathe the sweet, cool air, after a hot sultry day. The climate here is so mild and warm, even in the winter, that plenty of green pease, artichokes, asparagus, and other vegetables, may be had so early as the beginning of the new year, and even all the winter. This city swarms with monks and nuns of all sorts, to such a degree, that there are no less than 19 convents of the Dominicans alone, 18 of the Franciscans, 8 of the Augustines, and in pro-

portion of the rest. The magnificence of many of the churches exceeds imagination. In a cloyster of the Carthusian monastery is a crucifix, said to be done by Michael Angelo, of imitable workmanship. The fortifications of Naples are very strong, both towards the land and the sea, there being no less than five castles: yet the city is far from being secure from a bombardment; for the sea is so deep, that a large vessel may come up to the very mole, and there is nothing to prevent an enemy's approaches on that side, but a few galleys, the mole, and two small castles. Pictures, statues, and antiquities, are not so common in Naples, as might be expected in so great and ancient a city, many of the most valuable pieces having been sent to Spain by the viceroys. The bay is one of the finest in the world, being almost of a round figure, of about 30 miles in the diameter, and three parts of it sheltered with a noble circuit of woods and mountains. The city stands in the bosom of this bay, in as pleasant a situation, perhaps, as in the world. Mr Keyser says, they reckon about 18000 *donne libere*, or courtizans, in the city. Though the common people are generally so lazy as to prefer beggary or robbing to labour; yet there are some flourishing manufactures here, and a brisk trade. The city is supplied with a vast quantity of water, by means of a very costly aqueduct, from the foot of Mount Vesuvius. Mr Addison says, it is incredible how great a multitude of retainers to the law there are in Naples, who find continual employment from the fiery temper of the inhabitants. There are five piazzas or squares in the city, appropriated to the nobility, viz. those called *Capuana*, *Nido*, *Montagna*, *Porto*, and *Porta Nuova*. Of all the palaces, that of the king is not only the most magnificent, but also in the best style of architecture. The cathedral, though Gothic, is a very grand splendid edifice. It is here that the head and blood of St Januarius, the tutelary saint of Naples, are kept, the latter in two glass or crystal vials. The pretended liquefaction of the dried blood, as soon as brought near the head of the saint, is a thing well known; Mr Addison says, it is one of the most bungling tricks he ever saw\*. The harbour is spacious, and kept in good repair. It is fortified with a mole, which runs above a quarter of a mile into the sea, and at the extremity has a high lantern to direct ships safely into the harbour. Luxury here is restrained by severe sumptuary laws, and the women are more closely confined than in any other city of Italy. Here is an university and two academies of wits, the one called *Gli Ardenti*, and the other *Gli Otiosi*. The nunnery for ladies of quality is said to be the largest in the whole world, containing no less than 350 nuns, besides servants. The Mount of Piety, or the office for advancing money to the poor, on pledges, at a low interest, or without any, has an income of upwards of 50000 ducats. The arsenal is said to contain arms for 50000 men. The walls of the city consist of hard black quarry stones, called *piperno*.—Instead of ice, vast quantities of snow are used for cooling their liquors, not so much as water being drank without it; so that, it is said, a scarcity of it would as soon occasion a mutiny as a dearth of corn or provisions. Certain persons, who form the monopoly of it from the government, supply the city all the year round from

Naples.

\* See  
Chemistry,  
no 237.

from a mountain about 18 miles off, at so much the pound. Naples stands 110 miles south-east from Rome, 164 north-east from Palermo in Sicily, 217 south-east from Florence, and 300 from Venice. E. Long. 14. 20. N. Lat. 40. 55.

**NARBO**, (anc. geog.) a town of the Volcæ Teetofages, called also *Narbo Martius*, from the Legio Martia, the colony led thither 59 years before the consulate of Cæsar, (Velleius); increased with a colony of the Decumani or tenth legion by Cæsar. An ancient trading town on the Atax, which discharges itself into the sea through the Lacus Rubefusus, or Rubrensis. Capital of the Gallia Narbonensis; surnamed *Colonia Julia Paterna*, from Julius Cæsar, the father of Augustus by adoption. Now called *Narbonne*, a city of Languedoc.

**NARBONNE**, an ancient and large city of France, in Lower Languedoc, with an archbishop's see, and famous for its honey. It is feated on a canal cut from the river Aude, which being but three miles from the sea, vessels come up it laden with merchandize, which renders it a place of great trade. It is very ancient, being built in the time of the Romans; and the ruins of a capital, an amphitheatre, and several other buildings, still remain. It is divided into the city and the town, which are joined together by a bridge, with houses on each side, in which the richest merchants live. There are several churches and convents, and the metropolitan church has a handsome steeple. E. Long. 2. 6. N. Lat. 43. 11.

**NARCISSUS**, in fabulous history, the son of the river Cephalus and Liriope, the daughter of Oceanus, was a youth of great beauty. Tirias foretold that he should live till he saw himself. He despised all the nymphs of the country; and made Echo languish till she became a mere sound, by refusing to return her passion: but one day coming weary and fatigued from the chase, he stopped on the bank of a fountain to quench his thirst; when, seeing his own form in the water, he became so in love with the shadowy image, that he languished till he died. On which the gods, being moved at his death, changed him into the flower which bears his name.

**NARCISSUS**, a genus of the monogynia order, belonging to the hexandria class of plants. The most remarkable species are,

1. The baldard narcissus, or common yellow English daffodil, grows wild in great plenty in many of our woods and coppices, and under hedges in several parts of England. In the counties round London the herb-folks bring prodigious quantities in the spring of the year, when in bloom, root and all, and sell them about the streets. Its commonness renders it of but little esteem with many; considered, however, as an early and elegant flower, of exceeding hardiness and easy culture, it merits a place in every garden.

2. The bicolor, or two-coloured incomparable narcissus, hath a large, oblong, bulbous root; crowned with long, narrow, dark-green leaves, 12 or 14 inches long; an upright flower-stalk, about 15 inches high, terminated by an unisporous spathe, protruding one large flower with white petals, and a bell-shaped, spreading, golden nectarium, waved on the margin, and equal in length with the corolla; flowering in April. The varieties are, common single-flowered—

semi-double-flowered, with the interior petals some white, and some yellow—with sulphur-coloured flowers.

3. The poeticus, poetic daffodil, or common white narcissus, is well known. Of this there are varieties with purple-cupped flowers—yellow-cupped flowers—double-flowered: all of them with entire white petals. It is the ancient celebrated narcissus of the Greek and Roman poets, which they too greatly extol for its extreme beauty and fragrance.

4. The bulbocodium, hath a small bulbous root, crowned with several narrow, subulate, rush-like leaves, six or eight inches long; amidst them a slender, taper flower-stalk, six inches high, terminated by an unisporous spathe, protruding one yellow flower, having the nectarium much larger than the petals, and very broad and spreading at the brim; flowering in April. From the large spreading nectarium of this species, which being three or four times longer than the petals, narrow at bottom, and widening gradually to the brim, so as to resemble the shape of some old-fashioned hoop-petticoats, it obtained the name *hoop-petticoat narcissus*.

5. The ferotinus, or late-flowering small autumnal narcissus, hath a small bulbous root; crowned with a few narrow leaves; amidst them a jointed flower-stalk, eight or nine inches high, terminated by an unisporous spathe, protruding one white flower, having a short, six-parted, yellow nectarium; flowering in autumn.

6. The tazetta, or multiflorous daffodil, commonly called *polyanthus narcissus*, hath a very large, roundish, bulbous root; long, narrow, plane leaves; an upright flower-stalk, rising from 10 or 12 inches to a foot and a half high; terminated by a multiflorous spathe, protruding many large, spreading, white and yellow flowers, in a cluster, having bell-shaped nectariums shorter than the corolla; flowering in February, March, and April, and is very fragrant. The varieties of this are very numerous, consisting of about eight or nine principal sorts, each of which having many intermediate varieties; amounting in the whole greatly above an hundred in the Dutch florists catalogues, each variety distinguished by a name according to the fancy of the first raiser of it. They are all very pretty flowers, and make a charming appearance in the flower-borders, &c. they are also finely adapted for blowing in glasses of water, or in pots, to ornament rooms in winter.

7. The jonquilla, or jonquil, sometimes called *russh-leaved daffodil*, hath an oblong, bulbous, brown root; sending up several long, semi-taper, rush-like, bright-green leaves; amidst them an upright green flower-stalk, a foot or 15 inches high; terminated by a multiflorous spathe, protruding many yellow flowers, often expanded like a radius, each having a hemispherical, crenated nectarium, shorter than the petals; flowering in April, and mostly of a fine fragrance. The varieties are, Jonquil minor with single flowers—jonquil major with single flowers—flurry flowered—yellow and white flowered—white-flowered—semi-double-flowered—double-flowered—and large double inodorous jonquil: all of them multiflorous, the singles in particular; but sometimes the doubles produce only two or three flowers from a spathe, and the singles commonly six or eight. All the sorts have so fine a shape,

*Narcissus*. shape, so soft a colour, and so sweet a scent, that they are some of the most agreeable spring-flowers.

8. The calathinus, or multiflorous yellow narcissus, hath a large bulbous root; crowned with long, narrow, plane leaves; and amidst them an erect, robust flower-stalk, terminated by a multiflorous spatha, protruding many large, entire, yellow flowers having a bell-shaped, slightly crenated nectarium, equal in length with the petals.

9. The odoros, odoriferous or sweet scented flarry yellow narcissus, hath a bulbous root; narrow leaves; erect flower-stalk, a foot or more high, terminated by a sub-multiflorous spatha, protruding sometimes but one, and sometimes several entirely yellow flowers, having a campanulated, six-parted, smooth nectarium, half the length of the petals.

10. The triandrus, or triandrous rush-leaved white narcissus, hath a bulbous root; very narrow, rush-like leaves; erect flower-stalk, terminated by an uniflorous spatha, protruding one snowy-white flower, having a bell-shaped, crenated nectarium, half the length of the petals, and with mostly triandrous or three stamina.

11. The trilobus, or trilobate yellow narcissus, hath a bulbous root; narrow rush-like leaves; erect flower-stalks, terminated by a sub-multiflorous spatha, protruding sometimes but one or two, and sometimes several, yellow flowers, having a bell-shaped, three-lobed nectarium, half the length of the petals.

12. The minor, or yellow winter daffodil, hath a small bulbous root; plane leaves, eight or ten inches long, and more than half a one broad; an erect flower-stalk, terminated by an uniflorous spatha, protruding one nodding yellow flower, with spear-shaped petals, having an obconic, six-parted, waved nectarium, equal to the length of the corolla; flowering in winter, or very early in spring.

All these 12 species of narcissus are of the bulbous-rooted tribe, and universally perennial in root, but annual in leaf and flower-stalk; all of them rising annually in spring, immediately from the crown of the bulb, first the leaves, and in the midst of them the flower-stalk, one only from each root, entirely naked or leafless, each terminated by a spatha or sheath, which opens on one side to protrude the flowers, and then withers; the flowers, as before observed, are all hexapetalous, each furnished with a nectarium in the centre, and are universally hermaphrodite: they are large and conspicuous, appearing mostly in the spring-season, generally from March or April until June, succeeded by ripe seed in July; then the leaves and flower-stalks decay, and the roots desist from growing for some time; at which period of rest is the only proper time to take up or transplant the roots from one place to another, or to separate the offsets; for they all multiply abundantly by offset young bulbs from the main root, inasmuch that a single bulb will in one or two years be increased into a large cluster of several bulbs, closely placed together, and which every second or third year should be taken up at the above period in order to be separated; and each offset so separated commences a distinct plant, which being planted again in autumn, produces flowers the following summer, alike in every respect to those of their respective parent-bulbs. All the species are so hardy that they prosper

in any common soil of a garden: observing, however, to allow the finer sorts of *polyanthus narcissus*, in particular, principally a warm dry situation; all the others may be planted any where in the open dry borders and flower-beds.

NARCOTICS, in medicine, soporiferous drugs, which bring on a stupefaction. Among narcotics the most eminent are those usually prepared for medicinal uses of the whole poppy, especially opium; as also all those prepared of mandragoras, hyosciamus, stramonium, and datura.

NARDO, a pretty populous town in the kingdom of Naples, and in the Terra d'Otranto, with the title of a duchy and a bishop's see. E. Long. 18. 27. N. Lat. 43. 28.

NARRATION, in oratory, poetry, and history, a recital or rehearsal of a fact as it happened, or when it is supposed to have happened. See ORATORY, n<sup>o</sup> 26. 123.

Concerning NARRATION and Description, we have the following rules and observations in the Elements of Criticism.

1. The first rule is, That in history the reflections ought to be chaste and solid; for while the mind is intent upon truth, it is little disposed to the operations of the imagination. Strada's Belgic history is full of poetical images, which, being discordant with the subject, are unpleasant; and they have a still worse effect, by giving an air of fiction to a genuine history. Such flowers ought to be scattered with a sparing hand, even in epic poetry; and at no rate are they proper, till the reader be warmed, and by an enlivened imagination be prepared to relish them: in that state of mind, they are agreeable; but while we are sedate and attentive to an historical chain of facts, we reject with disdain every fiction.

2. Vida, following Horace, recommends a modest commencement of an epic poem; giving for a reason, That the writer ought to husband his fire. Besides, bold thoughts and figures are never relished till the mind be heated and thoroughly engaged, which is not the reader's case at the commencement. Homer introduces not a single simile in the first book of the Iliad, nor in the first book of the Odyssey. On the other hand, Shakespear begins one of his plays with a sentiment too bold for the most heated imagination:

*Bedford.* Hung be the heav'n's with black, yield day to night!

Comets, importing change of times and states,  
Brandish your crystal tresses in the sky,  
And with them scourge the bad revolting stars,  
That have consented unto Henry's death!  
Henry the Fifth, too famous to live long!  
England ne'er lost a king of so much worth.

*First part Henry VI.*

The passage with which Strada begins his history, is too poetical for a subject of that kind; and at any rate too high for the beginning of a grave performance.

3. A third rule or observation is, That where the subject is intended for entertainment solely, not for instruction, a thing ought to be described as it appears, not as it is in reality. In running, for example, the impulse upon the ground is proportioned in some degree

Narcotics  
||  
Narration.



Narration. agree to the celerity of motion; and though in appearance it is otherwise, for a person in swift motion seems to skim the ground, and scarcely to touch it. Virgil, with great taste, describes quick running according to appearance; and raises an image far more lively, than by adhering scrupulously to truth:

Hos super adventi Volvca de gente Camilla,  
Agmen agens equitum et florentes ære catervas,  
Bellatrix: non illa colo calathivæ Minervæ  
Fœminæ affueta manus; sed prælia virgo  
Dura pati, cursuque pedum prævertere ventos.  
Illa vel intactæ fegetis per summa volaret  
Gramina: nec teneras cursu læssisset aristas:  
Vel mare per medium, fluctu suspensa tumentis,  
Ferret iter; celeres nec tingeret æquore plantas.

*Æneid. vii. 803.*

4. In narration as well as in description, objects ought to be painted so accurately as to form in the mind of the reader distinct and lively images. Every useless circumstance ought indeed to be suppressed, because every such circumstance loads the narration; but if a circumstance be necessary, however slight, it cannot be described too minutely. The force of language consists in raising complete images; which have the effect to transport the reader as by magic into the very place of the important action, and to convert him as it were into a spectator, beholding every thing that passes. The narrative in an epic poem ought to rival a picture in the liveliness and accuracy of its representations: no circumstance must be omitted that tends to make a complete image; because an imperfect image, as well as any other imperfect conception, is cold and uninteresting. We shall illustrate this rule by several examples, giving the first place to a beautiful passage from Virgil:

Qualis populeæ mœrens Philomela sub umbrâ  
Amisso queritur fœtus, quos durus arator  
Observans uido implumes detrahit.

*Georg. lib. 4. l. 511.*

The poplar, plowman, and unfledged young, though not essential in the description, tend to make a complete image, and upon that account are an embellishment.

Again:

Hic viridem Æneas frondenti ex ilice metam  
Constituit, signum nautis. *Æneid. v. 129.*

Horace addressing to fortune:

Te pauper ambit sollicita prece  
Ruris colonus: te dominam æquoris,  
Quicumque Bithynâ læcessit  
Carpathium pelagus carinâ.

*Carm. lib. 1. ode 35.*

— Illum ex mœnibus hofius  
Matrona bellantis tyranni  
Prospiciens, et adulta virgo,  
Suffiret: Eheu, ne rudis agminum  
Sponsus læcessat regius asperum  
Tactu leonem, quem cruenta  
Per medias rapit ira cædes.

*Carm. lib. 3. ode 2.*

Shakspear says, "You may as well go about to turn the sun to ice by fanning in his face with a peacock's feather." The peacock's feather, not to mention the

beauty of the object, completes the image: an accurate image cannot be formed of that fanciful operation, without conceiving a particular feather; and one is at a loss when this is neglected in the description. Again, "The rogues slighted me into the river with as little remorse, as they would have drown'd a bitch's blind puppies, fifteen i' th' litter."

*Old Lady.* You would not be a queen?

*Anne.* No, not for all the riches under heaven.

*Old Lady.* 'Tis strange: a three-pence bow'd would hire me, old as I am, to queen it.

*Henry VIII. act. 2. sc. 5.*

In the following passage, the action, with all its material circumstances, is represented so much to the life, that it would scarce appear more distinct to a real spectator; and it is the manner of description that contributes greatly to the sublimity of the passage.

He spake; and to confirm his words, out-slew Millions of flaming swords, drawn from the thighs Of mighty cherubim; the sudden blaze Far round illumin'd hell: highly they rag'd Against the Highest, and fierce with grasped arms, Clash'd on their sounding shields the din of war, Hurling defiance toward the vault of heav'n.

*Milton, b. 1.*

The following passage from Shakspeare falls not much short of that now mentioned in particularity of description:

O you hard hearts! you cruel men of Rome!  
Knew you not Pompey? Many a time and oft  
Have you climb'd up to walls and battlements,  
To towers and windows, yea, to chimney-tops,  
Your infants in your arms; and there have sat  
The live-long day with patient expectation  
To see great Pompey pass the streets of Rome;  
And when you saw his chariot but appear,  
Have you not made an universal shout,  
That Tyber trembled underneath his banks,  
To hear the replication of your sounds,  
Made in his concave shores?

*Julius Cæsar, act 1. sc. 1.*

The following passage is scarce inferior to either of those mentioned:

"Far before the rest, the son of Ossian comes; bright in the smiles of youth, fair as the first beams of the sun. His long hair waves on his back: his dark brow is half beneath his helmet. The sword hangs loose on the hero's side; and his spear glitters as he moves. I fled from his terrible eye, King of high Temora." *Fingal.*

The Henriade of Voltaire errs greatly against the foregoing rule: every incident is touched in a summary way, without ever descending to circumstances. This manner is good in a general history, the purpose of which is to record important transactions: but in a fable it is cold and uninteresting; because it is impracticable to form distinct images of persons or things represented in a manner so superficial.

It is observed above, that every useless circumstance ought to be suppressed. The crowding such circumstances is, on the one hand, not less to be avoided, than the conciseness for which Voltaire is blamed, on the other. In the *Æneid*, Barce, the nurse of Si-

clizus,

*Narration.* chæus, whom we never hear of before nor after, is introduced for a purpose not more important than to call Anna to her sister Dido: and that it might not be thought unjust in Dido, even in this trivial circumstance, to prefer her husband's nurse before her own, the poet takes care to inform his reader, that Dido's nurse was dead. To this may be opposed a beautiful passage in the same book, where, after Dido's last speech, the poet, without detaining his readers by describing the manner of her death, hastens to the lamentation of her attendants:

Dixerat: atque illam media inter talia ferro  
Collapsam aspiciunt comites, ensemque cruore  
Spumantem, sparfasque manus. It clamor ad alta  
Atria, concussam bacchantur fama per urbem;  
Lamentis gemituque et fœmineo ululatu  
Tectâ fremunt, resonat magnis plangoribus æther.  
*Lib. 4. l. 663.*

As an appendix to the foregoing rule, may be added the following observation, That to make a sudden and strong impression, some single circumstance, happily selected, has more power than the most labour'd description. Macbeth, mentioning to his lady some voices he heard while he was murdering the King, says,

There's one did laugh in sleep, and one cry'd Murder!  
They wak'd each other; and I flood and heard them;  
But they did say their prayers, and address them  
Again to sleep.

*Lady.* There are two lodg'd together.

*Macbeth.* One cry'd, God bless us! and, Amen!  
the other;

As they had seen me with these hangman's hands,  
Lifting their fear, I could not say, Amen,  
When they did say, God bless us.

*Lady.* Consider it not so deeply.

*Macbeth.* But wherefore could not I pronounce  
Amen?

I had most need of blessing, and Amen  
Stuck in my throat.

*Lady.* These deeds must not be thought  
After these ways; so, it will make us mad.

*Macbeth.* Methought, I heard a voice cry,  
Sleep no more!

Macbeth doth murder sleep, &c. *Act 2. sc. 3.*

Describing prince Henry:

I saw young Harry, with his beaver on,  
His cuisses on his thighs, gallantly arm'd,  
Rise from the ground like feather'd Mercury;  
And vaulted with such ease into his seat,  
As if an angel dropt down from the clouds,  
To turn and wind a fiery Pegasus,  
And witch the world with noble horsemanship.

*First part Henry IV. act 4. sc. 2.*

*King Henry.* Lord Cardinal, if thou think'st on  
Heaven's bliss,

Hold up thy hand, make signal of thy hope.  
He dies, and makes no sign!

*Second part Henry VI. act 3. sc. 10.*

The same author, speaking ludicrously of an army debilitated with diseases, says,

"Half of them dare not shake the snow from off  
their cassocks, lest they shake themselves to pieces."

"I have seen the walls of Balchuth, but they were  
desolate. The flames had resounded in the halls: and  
the voice of the people is heard no more. The stream  
of Clutha was removed from its place by the fall of the  
walls. The thistle shook there its lonely head: the  
moss whistled to the wind. The fox looked out from  
the windows: and the rank grass of the wall waved  
round his head. Desolate is the dwelling of Morna:  
silence is in the house of her fathers."  
*Fingal.*

To draw a character is the master-stroke of description. In this Tacitus excels: his portraits are natural and lively, not a feature wanting or misplaced. Shakespeare, however, exceeds Tacitus in liveliness; some characteristic circumstance being generally invented or laid hold of, which paints more to the life than many words. The following instances will explain our meaning, and at the same time prove our observation to be just.

Why should a man, whose blood is warm within,  
Sit like his grandfire cut in alabaster?

Sleep when he wakes, and creep into the jaundice,

By being peevish? I tell thee what, Antonio,

(I love thee, and it is my love that speaks),

'There are a sort of men, whose vilages

Do cream and mantle like a standing pond;

And do a wilful stillness entertain,

With purpose to be dress'd in an opinion

Of wisdom, gravity, profound conceit;

As who should say, I am Sir Oracle;

And when I ope my lips, let no dog bark!

O my Antonio! I do know of those,

That therefore only are reputed wise,

For saying nothing.

*Merchant of Venice, act. 1. sc. 2.*

Again:

"Gratiano speaks an infinite deal of nothing, more  
than any man in all Venice: his reasons are two grains  
of wheat hid in two bushels of chaff; you shall seek all  
day ere you find them; and when you have them, they  
are not worth the search."  
*Ibid.*

In the following passage, a character is completed by  
a single stroke:

*Shallow.* O the mad days that I have spent; and to  
see how many of mine old acquaintance are dead.

*Silence.* We shall all follow, cousin.

*Shallow.* Certain, 'tis certain, very sure, very sure;  
Death (as the Psalmist saith) is certain to all: all shall  
die. How a good yoke of bullocks at Stamford fair?

*Slender.* Truly, cousin, I was not there.

*Shallow.* Death is certain. Is old Double of your  
town living yet?

*Silence.* Dead, Sir.

*Shallow.* Dead! tee, tee; he drew a good bow; and  
dead. He shot a fine shoot. How a score of ewes now?

*Silence.* Thereafter as they be. A score of good  
ewes may be worth ten pounds.

*Shallow.* And is old Double dead?

*Second part Henry IV. act. 3. sc. 3.*

Describing a jealous husband:

"Neither press, coffer, chest, trunk, well, walt, but  
he hath an abstract for the remembrance of such places,  
and goes to them by his note. There is no hiding you  
in the house."  
*Merry Wives of Windsor, act. 4. sc. 3.*

Congreve

Narration. Congreve has an inimitable stroke of this kind in his comedy of *Love for Love*:

*Ben Legend.* Well, father, and how do all at home? how does brother Dick, and brother Val?

*Sir Sampson.* Dick, body o' me, Dick has been dead these two years. I write you word when you were at Lephorn.

*Ben.* Mef, that's true; marry, I had forgot. Dick's dead, as you fay. *Act 3. sc. 6.*

Falstaff speaking of Ancient Pistol:

"He's no swaggerer, hofefs; a tame cheater i' faith; you may froak him as gently as a puppy-greyhound; he will not swagger with a Barbary hen, if her feathers turn back in any shew of resistance."

*Second part Henry IV. act 2. sc. 9.*

Ossian among his other excellencies is eminently successful in drawing characters; and he never fails to delight his reader with the beautiful attitudes of his heroes. Take the following instances:

"O Oscar! bend the strong in arm; but spare the feeble hand. Be thou a stream of many tides against the foes of thy people; but like the gale that moves the grafs to those who ask thine aid.—So Tremor lived; such Trathal was; and such has Fingal been. My arm was the support of the injured; and the weak rested behind the lightning of my steel."

"We heard the voice of joy on the coast, and we thought that the mighty Cathmor came. Cathmor the friend of strangers! the brother of red-haired Cairbar! But their fouls were not the same; for the light of heaven was in the bosom of Cathmor. His towers rose on the banks of Acha: seven paths led to his halls: seven chiefs flood on these paths, and called the stranger to the feast. But Cathmor dwelt in the wood to avoid the voice of praise."

"Dermid and Oscar were one: they reaped the battle together. Their friendship was strong as their steel; and death walked between them to the field. They rush on the foe like two rocks falling from the brow of Ardden. Their swords are stained with the blood of the valiant; warriors faint at their name. Who is equal to Oscar but Dermid? who to Dermid but Oscar?"

"Son of Comhal, replied the chief, the strength of Morni's arm has failed: I attempt to draw the sword of my youth, but it remains in its place: I throw the spear, but it falls short of the mark; and I feel the weight of my shield. We decay like the grafs of the mountain, and our strength returns no more. I have a son, O Fingal! his soul has delighted in the actions of Morni's youth; but his sword has not been fitted against the foe, neither has his fame begun. I come with him to battle, to direct his arm. His renown will be a fun to my soul, in the dark hour of my departure. O that the name of Morni were forgot among the people! that the heroes would only say, Behold the father of Gaul."

Some writers, through heat of imagination, fall into contradiction; some are guilty of downright absurdities; and some even rave like madmen. Against such capital errors one cannot be more effectually warned than by collecting instances; and the first shall be of a

contradiction, the most venial of all. Virgil speaking of Neptune,

Interea magno miscere murmure pontum,  
Emiffamque hyemem fenfit Neptunus, et imis  
Stagna refusa vadis: graviter commotus, et alto  
Profpicies, fumma placidum caput exulit unda.

*Eneid. i. 128.*

Again:

When first young Maro, in his boundless mind,  
A work t'outlast immortal Rome designed.

*Essay on Criticism, l. 30.*

The following examples are of absurdities.

"Alii pulsus tormento catenis discreti fectique,  
dimidiato corpore pugnabant sibi superstitis, ac pemptæ partes ultores."

*Strada, dec. 2. l. 2.*

Il pover huomo, che non sen'era accorto,  
Andava combattendo, ed era morto. *Berni.*

He fled, but flying, left his life behind.

*Iliad xi. 443.*

Full through his neck the weighty falchion sped:  
Along the pavement roll'd the mutt'ring head.

*Odyssey xxii. 365.*

The last article is of raving like one mad. Cleopatra speaking to the asp,ic,

—Welcome, thou kind deceiver,

Thou best of thieves; who, with an easy key,  
Dost open life, and unperceiv'd by us  
Even steal us from ourselves; discharging so  
Death's dreadful office, better than himself;  
Touching our limbs so gently into slumber,  
That Death stands by, deceiv'd by his own image,  
And thinks himself but sleep.

*Dryden, All for Love, act 5.*

Having discussed what observations occurred upon the thoughts or things expressed, we proceed to what more peculiarly concern the language or verbal dress. As words are intimately connected with the ideas they represent, the emotions raised by the sound and by the sense ought to be concordant. An elevated subject requires an elevated style; what is familiar, ought to be familiarly expressed: a subject that is serious and important, ought to be clothed in plain nervous language: a description, on the other hand, addressed to the imagination, is susceptible of the highest ornaments that sounding words and figurative expression can bestow upon it.

We shall give a few examples of the foregoing rules. A poet of any genius is not apt to dress a high subject in low words; and yet blemishes of that kind are found even in classical works. Horace, observing that men are satisfied with themselves, but seldom with their condition, introduces Jupiter indulging to each his own choice:

Jam faciam quod vultis: eris tu, qui modo miles,  
Mercator: tu, consilium modo, rutilicus: hinc vos,  
Vos hinc mutatis discedite partibus: eia.  
Quid statis? nolint: atqui licet esse beatis.  
Quid causæ est, merito quin illis Jupiter ambas  
Iratas buccas infuset? neque se fore poetæ  
Tam facilem dicat, votis ut præbeat aurem?

*Sat. lib. 1. sat. 1. l. 16.*

Jupiter in wrath puffing up both cheeks, is a low and even ludicrous expression, far from suitable to the gravity

Narration. vity and importance of the subject: every one must feel the discordance. The following couplet, sinking far below the subject, is no less ludicrous:

Not one looks backward, onward still he goes,  
Yet ne'er looks forward farther than his nose.

*Essay on Man, ep. iv. 223.*

On the other hand, to raise the expression above the tone of the subject, is a fault than which none is more common. Take the following instances:

Orcan le plus fidèle à servir ses desseins,  
Ne fous le ciel brûlant des plus noirs Africains.

*Bajazet, act 3. sc. 8.*

Les ombres par trois fois ont obscurci les cieus  
Depuis que le sommeil n'est entré dans vos yeux;  
Et le jour a trois fois chassé la nuit obscure  
Depuis que votre corps languit fans nourriture.

*Phedra, act 1. sc. 3.*

*Affueris.* Ce mortel, qui mourra tant de zèle pour  
moi, Vit-il encore?

*Asaph.* — Il voit l'astre qui vous éclaire.

*Ezher, act 2. sc. 3.*

Oui, c'est Agamemnon, c'est ton roi qui t'éveille;  
Viens, reconnois la voix qui frappe ton oreille.

*Iphigenie.*

No jocund health that Denmark drinks to-day,  
But the great cannon to the clouds shall tell;  
And the king's rouse the heav'n shall bruit again,  
Respeaking earthly thunder.

*Hamlet, act 1. sc. 2.*

————— In the inner room

I spy a winking lamp, that weakly strikes  
The ambient air, scarce kindling into light.

*Southerne, Fate of Capua, act 3.*

In the funeral orations of the bishop of Meaux, the following passages are raised far above the tone of the subject:

“ L'Océan étonné de se voir traversé tant de fois, en des appareils si divers, et pour des causes si différentes, &c.”

*p. 6.*

“ Grande reine, je satisfais à vos plus tendres desirs, quand je célèbre ce monarque; et son cœur qui n'a jamais vécu que pour lui, seveille, tout poudre qu'il est, et devient sensible, même sous ce drap mortuaire, au nom d'un époux si cher.”

*p. 32.*

The following passage, intended, one would imagine, as a receipt to boil water, is altogether burlesque by the laboured elevation of the diction:

A massy caldron of stupendous frame  
They brought, and plac'd it o'er the rising flame:  
Then heigh the lighted wood; the flame divides  
Beneath the vase, and climbs around the sides:  
In its wide womb they pour the rushing stream:  
The boiling water bubbles to the brim.

*Iliad. xviii. 405.*

In a passage at the beginning of the 4th book of Telemachus, one feels a sudden bound upward without preparation, which accords not with the subject:

“ Calypso, qui avoit été jusqu'à ce moment immobile et transportée de plaisir en écoutant les aventures de Télémaque, l'interrompt pour lui faire prendre quelque repos. Il est tenu, lui dit-elle, que vous aliez goûter la douceur du sommeil après tant de travaux. Vous n'avez rien à craindre ici; tout vous est favora-

ble. Abandonnez vous donc à la joye. Goutez la paix, et tous les autres dons de dieux dont vous allez être comblé. Demain, quand l'Aurore avec ses doigts de roses entr'ouvrira les portes dorées de l'Orient, et que le cheveau du soleil sortant de l'onde amère répandra sur les flammes du jour, pour chasser devant eux toutes les étoiles du ciel, nous reprendrons, mon cher Télémaque, l'histoire de vos malheurs.”

This obviously is copied from a similar passage in the *Æneid*, which ought not to have been copied, because it lies open to the same censure; but the force of authority is great:

At regina gravi jamdudum faucia cura  
Vulnus alit venis, et cæco carpitur igni.  
Multa viri virtus animo, multaque recurfat  
Gentis honos: hærent infixi pectore vultus,  
Verbaque: nec placidam membris dat cura quietem.  
*Postera Phœbea lustrabat lampade terras,  
Humentemque Aurora polo dimoverat unbram,  
Cum sic unanimum alloquitur malefana forem.*

*Lih. iv. 1*

The language of Homer is suited to his subject, not less accurately than the actions and sentiments of his heroes are to their characters. Virgil, in that particular, falls short of perfection: his language is flatly throughout: and though he descends at times to the simplest branches of cookery, roasting and boiling for example, yet he never relaxes a moment from the high tone. In adjusting his language to his subject, no writer equals Swift. We can recollect but one exception, which at the same time is far from being gross: The Journal of a modern Lady is composed in a style blending sprightliness with familiarity, perfectly suited to the subject: in one passage, however, the poet, deviating from that style, takes a tone above his subject. The passage we have in view begins *l. 116. But let me now a wibble survey, &c.* and ends at *l. 135.*

It is proper to be observed upon this head, that writers of inferior rank are continually upon the stretch to enliven and enforce their subject by exaggeration and superlatives. This unluckily has an effect contrary to what is intended: the reader, disgusted with language that swells above the subject, is led by contrast to think more meanly of the subject than it may possibly deserve. A man of prudence, beside, will be no less careful to husband his strength in writing than in walking: a writer too liberal of superlatives, exhausts his whole stock upon ordinary incidents, and reserves no share to express, with greater energy, matters of importance.

Many writers of that kind abound so in epithets, as if poetry consisted entirely in high-sounding words. Take the following instance:

When black-brow'd night her dusky mantle spread,  
And wrapt in solemn gloom the sable sky;  
When soothing sleep her opiate dew had shed,  
And seal'd in silken slumbers ev'ry eye:  
My wakeful thought admits no balmy rest,  
Nor the sweet bliss of soft oblivion share:  
But watchful wo distracts my aching breast,  
My heart the subject of corroding care:  
From haunts of men with wandering steps and slow  
I solitary steal, and sooth the my penive wo.

Here every substantive is faithfully attended by some tumid

Narration. tumid epithet.

Narration.

We proceed to a second remark, not less important than the former. No person of reflection but must be sensible, that an incident makes a stronger impression on an eye-witness, than when heard at second-hand. Writers of genius, sensible that the eye is the best avenue to the heart, represent every thing as passing in our sight; and, from readers or hearers, transform us as it were into spectators: a skilful writer conceals himself, and presents his personages: in a word, every thing becomes dramatic as much as possible. Plutarch, *de gloria Atheniensium*, observes, that Thucydides makes his reader a spectator, and inspires him with the same passions as if he were an eye-witness.

In the fine arts, it is a rule, to put the capital objects in the strongest point of view; and even to present them oftener than once, where it can be done. In history-painting, the principal figure is placed in the front, and in the best light: an equestrian statue is placed in a centre of streets, that it may be seen from many places at once. In no composition is there greater opportunity for this rule than in writing:

———— Sequitur pulcherrimus Astur,  
Astur equo fidens et vericoloribus armis.

*Æneid. x. 180.*

———— Full many a lady  
I've ey'd with best regard, and many a time  
Th' harmony of their tongues hath into bondage  
Brought my too diligent ear: for several virtues  
Have I lik'd several women; never any  
With so full soul, but some defect in her  
Did quarrel with the noblest grace she ow'd,  
And put it to the foil. But you, O you,  
So perfect, and so peerless, are created  
Of every creature's best. *Tempest, act 3. sc. 1.*

*Orlando.* ——— What'er you are  
That, in the desert inaccessible,  
Under the shade of melancholy boughs,  
Lose and neglect the creeping hours of time;  
If ever you have look'd on better days;  
If ever been where bells have knoll'd to church;  
If ever fat at any good man's feast;  
If ever from your eye-lids wip'd a tear,  
And know what 'tis to pity, and be pity'd;  
Let gentleness my strong enforcement be,  
In the which hope I blush, and hide my sword.

*Duke sen.* True is it that we have seen better days;  
And with holy bell have knoll'd to church;  
And fat at good mens feasts; and wip'd our eyes  
Of drops that sacred pity had engender'd:  
And therefore fit you down in gentleness,  
And take upon command what help we have,  
That to your wanting may be ministr'd.

*As you like it.*

With the conversing I forgot all time;  
All seasons and their change, all please alike.  
Sweet is the breath of morn, her rising sweet,  
With charm of earliest birds; pleasant the fun  
When first on this delightful land he spreads  
His orient beams, on herbs, tree, fruit, and flow'r  
Glittering with dew; fragrant the fertile earth  
After soft show'rs; and sweet the coming on  
Of grateful ev'ning mild, the silent night  
With this her solemn bird, and this fair moon,  
And these the gems of heav'n, her starry train:

VOL. VII.

2

But neither breath of morn, when she ascends  
With charm of earliest birds, nor rising fun  
On this delightful land, nor herb, fruit, flow'r,  
Glittering with dew, nor fragrance after show'rs,  
Nor grateful ev'ning mild, nor silent night,  
With this her solemn bird, nor walk by moon,  
Or glittering star-light, without thee is sweet.

*Paradise Lost, book 4. l. 634.*

“What mean ye, that ye use this proverb, The fathers have eaten four grapes, and the childrens teeth are set on edge? As I live, saith the Lord God, ye shall not have occasion to use this proverb in Israel. If a man keep my judgments to deal truly, he is just, he shall surely live. But if he be a robber, a shedder of blood; if he have eaten upon the mountains, and defiled his neighbour's wife; if he have oppressed the poor and needy, have spoiled by violence, have not restored the pledge, have lift up his eyes to idols, have given forth upon usury, and have taken increase: shall he live? he shall not live: he shall surely die; and his blood shall be upon him. Now, lo, if he beget a son, that seeth all his father's sins, and considereth, and doeth not such like; that hath not eaten upon the mountains, hath not lift up his eyes to idols, nor defiled his neighbour's wife, hath not oppressed any, nor withheld the pledge, neither hath spoiled by violence, but hath given his bread to the hungry, and covered the naked with a garment; that hath not received usury nor increase, that hath executed my judgments, and walked in my statutes: he shall not die for the iniquity of his father; he shall surely live. The soul that sinneth, it shall die; the son shall not bear the iniquity of the father, neither shall the father bear the iniquity of the son; the righteousness of the righteous shall be upon him, and the wickedness of the wicked shall be upon him. Have I any pleasure that the wicked should die, saith the Lord God; and not that he should return from his ways, and live?” *Ezekiel xviii,*

A concise comprehensive style is a great ornament in narration; and a superfluity of unnecessary words, not less than of circumstances, a great nuisance. A judicious selection of the striking circumstances, clothed in a nervous style, is delightful. In this style, Tacitus excels all writers, ancient and modern. Instances are numberless: take the following specimen.

“*Cæbra hinc prælia, et sæpius in modum atrocium: per saltus, per paludes; ut cuique fors aut virtus: temerè, proviso, ob iram, ob prædam, iusto, et aliquando ignaris ducibus.*” *Annal. lib. 12. § 39.*

After Tacitus, Ossian in that respect justly merits the place of distinction. One cannot go wrong for examples in any part of the book.

If a concise or nervous style be a beauty, tautology must be a blemish; and yet writers, fettered by verse, are not sufficiently careful to avoid this slovenly practice: they may be pitied, but they cannot be justified. Take for a specimen the following instances, from the best poet, for verification at least, that England has to boast of.

High on his helm celestial lightnings play,  
His beamy shield emits a living ray;  
The unwear'd blaze incessant streams supplies,  
Like the red star that fires th' autumnal skies.

*Iliad v. 5.*

Strength

Strength and omnipotence invest thy throne.

*Ibid.* viii. 576.

So silent fountains, from a rock's tall head,  
In fable streams soft trickling waters shed.

*Ibid.* ix. 19.

His clanging armour rung.

*Ibid.* xii. 94.

Fear on their cheek, and horror in their eye.

*Ibid.* xv. 4.

The blaze of armour flash'd against the day.

*Ibid.* xvii. 736.

As when the piercing blasts of Boreas blow.

*Ibid.* xix. 380.

And like the moon, the broad refulgent shield  
Blaz'd with long rays, and gleam'd athwart the field.

*Ibid.* xix. 402.

No—could our swiftness o'er the winds prevail,  
Or beat the pinions of the western gale,

*Ibid.* xix. 604.

All were in vain—  
The humid sweat from ev'ry pore defends.

*Ibid.* xxiii. 829.

We close this article with a curious inquiry. An object, however ugly to the sight, is far from being so when represented by colours or by words. What is the cause of this difference? With respect to painting, the cause is obvious: a good picture, whatever the subject be, is agreeable by the pleasure we take in imitation; and this pleasure overbalancing the disagreeableness of the subject, makes the picture upon the whole agreeable. With respect to the description of an ugly object, the cause follows. To connect individuals in the social state, no particular contributes more than language, by the power it possesses of an expeditious communication of thought, and a lively representation of transactions. But nature hath not been satisfied to recommend language by its utility merely: independent of utility, it is made susceptible of many beauties, which are directly felt, without any intervening reflection. And this unfolds the mystery; for the pleasure of language is so great, as in a lively description to overbalance the disagreeableness of the image raised by it. This, however, is no encouragement to choose a disagreeable subject; for the pleasure is incomparably greater where the subject and the description are both of them agreeable.

The following description is upon the whole agreeable, though the subject described is in itself dismal:

Nine times the space that measures day and night  
To mortal men, he with his horrid crew  
Lay vanquish'd, rolling in the fiery gulf,  
Confounded though immortal! but his doom  
Reserv'd him to more wrath; for now the thought  
Both of lost happiness and lasting pain  
Torments him; round he throws his baleful eyes  
That witness'd huge affliction and dismay,  
Mix'd with obdurate pride and stedfast hate:  
At once as far as angels ken he views  
The dismal situation walt and wild:  
A dungeon horrible, on all sides round  
As one great furnace flamed; yet from those flames  
No light, but rather darkness visible  
Serv'd only to discover sights of woe,  
Regions of sorrow, doleful shades, where peace  
And rest can never dwell, hope never comes

That comes to all; but torture without end

Still urges, and a fiery deluge, fed

With ever-burning sulphur unconsum'd!

Such place eternal justice had prepar'd

For those rebellious. *Paradise lost, book. 1. l. 50.*

An unmanly depression of spirits in time of danger is not an agreeable sight; and yet a fine description or representation of it will be relished:

*K. Richard.* What must the King do now! must he submit?

The king shall do it: must he be depos'd?

The king shall be contented: must he lose

The name of king? o' God's name, let it go;

I'll give my jewels for a set of beads;

My gorgeous palace, for a hermitage;

My gay apparel, for an almsman's gown;

My figur'd goblets, for a dish of wood;

My sceptre, for a palmer's walking-staff;

My subjects, for a pair of carved saints;

And my large kingdom, for a little grave;

A little, little grave;—an obscure grave.

Or I'll be bury'd in the king's highway;

Some way of common tread, where subjects feet

May hourly trample on their sovereign's head;

For on my heart they tread now, whilst I live;

And, bury'd once, why not upon my head?

*Richard II. act. 3. sc. 6.*

Objects that strike terror in a spectator, have in poetry and painting a fine effect. The picture, by raising a slight emotion of terror, agitates the mind; and in that condition every beauty makes a deep impression. May not contrast heighten the pleasure, by opposing our present security to the danger of encountering the object represented?

—The other shape,

If shape it might be call'd, that shape had none

Distinguishable in member, joint, or limb;

Or substance might be call'd that shadow seem'd,

For each seem'd either; black it stood as night,

Fierce as ten furies, terrible as hell,

And shook a dreadful art. *Par. lost, b. 2. l. 666.*

—Now storming fury rofe,

And clamour such as heard in heaven till now

Was never: arms on clamour clashing bray'd

Horrible discord, and the madding wheels

Of brazen chariots rag'd; dire was the noise

Of conflict; overhead the dismal hiss

Of fiery darts in flaming volleys flew,

And flying vaulted either host with fire.

So under fiery cope together rush'd

Both battles main, with ruinous assault

And inextinguishable rage: all heaven

Refounded, and had earth been then, all earth

Had to her centre shook. *Ibid. book 6. l. 207.*

*Ghost.* — But that I am forbid

To tell the secrets of my prison-house,

I could a tale unfold, whose lightest word

Would harrow up thy soul, freeze thy young blood,

Make thy two eyes, like stars, start from their spheres,

Thy knotty and combined locks to part,

And each particular hair to stand on end,

Like quills upon the fretful porcupine:

But this eternal blazon must not be

To ears of flesh and blood. *Hamlet, act 1. sc. 8.*

*Gratiano.*

*Gratiano.* Poor Dede'mona! I'm glad thy father's dead:

Thy match was mortal to him; and pure grief  
Shore his old thread in twain. Did he live now,  
This fight would make him do a desperate turn:  
Yea, curse his better angel from his side,  
And fall to reprobation. *Othello, act 5. sc. 8.*

Objects of horror must be excepted from the foregoing theory; for no description, however lively, is sufficient to overbalance the disgust raised even by the idea of such objects. Every thing horrible ought therefore to be avoided in a description.

NARWAL, in ichthyology. See *MONODON*.

NASSAU-SIEGEN, a small principality of Germany in the Westerwald, is in general a mountainous woody country, with some arable and pasture ground, and a good breed of cattle. Its manufactures are chiefly those of iron and steel, having an iron mine in the neighbourhood of Siegen. Count John the Younger, in 1626, embraced the Roman Catholic religion, and endeavoured to introduce it into the country; but the principality, upon the extinction of the line of Nassau-Siegen in 1743, falling to the line of Nassau-Dietz, and therein to the prince of Orange, hereditary stadtholder of the United Provinces, the Protestants were delivered from their apprehensions of Popish tyranny and bigotry. The prince, on account of these territories, has a seat and voice at the diets of the empire and circle in the college of princes. His assent in the matricula for Nassau-Siegen is 773 florins monthly; and towards the maintenance of the chamber-judicatory, 50 rix-dollars six kruitzers and a half, each term. The revenue of this principality is estimated at 100,000 rix-dollars.

NASSAU-Dillenburg, a principality of Germany, situated near the former. It has not much arable land, but plenty of wood, good quarries of stone, some silver and vitriol, copper and lead, with store of iron, for the working and smelting of which there are many forges and founderies in the country; and by these, and the sale of their iron, the inhabitants chiefly subsist. Calvinism is the religion of the principality, which contains five towns and two boroughs, and belongs entirely to William V. prince of Orange, and hereditary stadtholder of the United Provinces, whose father succeeded to a part of it in 1739, on the death of prince Christian, and to the rest in 1743, on the death of prince William Hyacynth of Siegen. The prince, on account of this principality also and Dietz, has a seat and voice in the college of princes, at the diets of the empire and circle. His assent in the matricula, for Nassau-Dillenburg, is 102 florins monthly; and to the chamber-judicatory, 50 rix-dollars six and a half kruitzers, each term. His revenue from this principality is computed at above 130,000 florins.

NASSAU-Hadamar, a county of Germany, which, till the year 1711, had princes of its own; but now belongs wholly to William V. prince of Orange.

NATES, in anatomy, a term expressing those two fleshy exterior parts of the body vulgarly called the *buttocks*.

NATION, a collective term, used for a considerable number of people inhabiting a certain extent of

land, confined within fixed limits, and under the same government.

NATIONAL DEBT; the money owing by government.

In order to take a clear and comprehensive view of the nature of this national debt, it must first be premised, that after the Revolution, when new connections with Europe introduced a new system of foreign politics, the expences of the nation, not only in settling the new establishment, but in maintaining long wars, as principals, on the continent, for the security of the Dutch barrier, reducing the French monarchy, settling the Spanish succession, supporting the house of Austria, maintaining the liberties of the Germanic body, and other purposes, increased to an unusual degree: inasmuch, that it was not thought advisable to raise all the expences of any one year by taxes to be levied within that year, lest the unaccustomed weight of them should create murmuring among the people. It was therefore the policy of the times to anticipate the revenues of their posterity, by borrowing immense sums for the current service of the state, and to lay no more taxes upon the subject than would suffice to pay the annual interest of the sums so borrowed: by this means converting the principal debt into a new species of property, transferable from one man to another at any time and in any quantity. A system which seems to have had its original in the state of Florence, A. D. 1344: which government then owed about 60,000 l. Sterling; and being unable to pay it, formed the principal into an aggregate sum, called metaphorically a *mount* or *bank*, the shares whereof were transferable like our stocks, with interest at 5 per cent. the prices varying according to the exigencies of the state. This laid the foundation of what is called the *national debt*: for a few long annuities created in the reign of Charles II. will hardly deserve that name. And the example then set has been so closely followed during the long wars in the reign of queen Anne, and since, that the capital of the national debt, (funded and unfunded) amounted in January 1771 to above 140,000,000 l.; to pay the interest of which, and the charges of management, amounting annually to upwards of four millions and an half, the extraordinary revenues elsewhere enumerated † (excepting only the † See *Re-* land-tax and annual malt-tax) are in the first place *VENUE*. mortgaged and made perpetual by parliament. Perpetual we say; but still redeemable by the same authority that imposed them † which, if it at any time can pay off the capital, will abolish those taxes which are raised to discharge the interest.

By this means the quantity of property in the kingdom is greatly increased in idea, compared with former times; yet, if we coolly consider it, not at all increased in reality. We may boast of large fortunes, and quantities of money in the funds. But where does this money exist? It exists only in name, in paper, in public faith, in parliamentary security: and that is undoubtedly sufficient for the creditors of the public to rely on. But then what is the pledge which the public faith has pawned for the security of these debts? The land, the trade, and the personal industry of the subject; from which the money must arise that supplies the several taxes. In these therefore, and these

National. only, the property of the public creditors does really and intrinsically exist: and of course the land, the trade, and the personal industry of individuals, are diminished in their true value just so much as they are pledged to answer. If A's income amounts to 100 l. *per annum*; and he is so far indebted to B, that he pays him 50 l. *per annum* for his interest; one half of the value of A's property is transferred to B the creditor. The creditor's property exists in the demand which he has upon the debtor, and no where else; and the debtor is only a trustee to his creditor for one half of the value of his income. In short, the property of a creditor of the public consists in a certain portion of the national taxes: by how much therefore he is the richer, by so much the nation, which pays these taxes, is the poorer.

The only advantage, that can result to a nation from public debts, is the increase of circulation, by multiplying the cash of the kingdom, and creating a new species of currency, assignable at any time and in any quantity; always therefore ready to be employed in any beneficial undertaking, by means of this its transferable quality; and yet producing some profit even when it lies idle and unemployed. A certain proportion of debt seems to be highly useful to a trading people; but what that proportion is, it is not for us to determine. This much is indisputably certain, that the present magnitude of our national encumbrances very far exceeds all calculations of commercial benefit, and is productive of the greatest inconveniences. For, first, the enormous taxes, that are raised upon the necessaries of life for the payment of the interest of this debt, are a hurt both to trade and manufactures, by raising the price as well of the artificer's subsistence as of the raw material, and of course, in a much greater proportion, the price of the commodity itself. Nay, the very increase of paper-circulation itself, when extended beyond what is requisite for commerce or foreign exchange, has a natural tendency to increase the price of provisions as well as of all other merchandise. For as its effect is to multiply the cash of the kingdom, and this to such an extent, that much must remain unemployed, that cash (which is the universal measure of the respective values of all other commodities) must necessarily sink in its own value, and every thing grow comparatively dearer. Secondly, if part of this debt be owing to foreigners, either they draw out of the kingdom annually a considerable quantity of specie for the interest; or else it is made an argument to grant them unreasonable privileges in order to induce them to reside here. Thirdly, if the whole be owing to subjects only, it is then charging the active and industrious subject, who pays his share of the taxes to maintain the indolent and idle creditor who receives them. Lastly, and principally, it weakens the internal strength of a state, by anticipating those resources which should be reserved to defend it in case of necessity. The interest we now pay for our debts would be nearly sufficient to maintain any war that any national motives could require. And if our ancestors in king William's time had annually paid, so long as their exigencies lasted, even a less sum than we now annually raise upon their accounts, they would in the time of war have borne no greater burdens than they have bequeathed to

and settled upon their posterity in time of peace; and might have been eased the instant the exigence was over. See FUNDS.

Nativity  
N.  
Natum.

NATIVITY, or NATAL DAY, the day of a person's birth. The word *nativity* is chiefly used in speaking of the saints; as, the nativity of St John the Baptist, &c. But when we say the Nativity, it is understood of that of Jesus Christ, or the feast of Christmas.

NATOLIA, the modern name of the Lesser Asia, being the most westerly part of Turkey in Asia, and consisting of a large peninsula, which extends from the river Euphrates, as far as the Archipelago, the seas of Marmora, the straits of Galipoli and of Constantinople, which separate it from Europe on the west. It is bounded on the north by the Black sea, and on the south by the Mediterranean sea.

NATRUM, the nitre of the ancients, in natural history, is a genuine, pure, and native salt, extremely different from our nitre, and indeed from all the other native salts; it being a fixed alkali, plainly of the nature of those made by fire from vegetables, yet capable of a regular crystallization, which those salts are not. It is found on the surface of the earth, or at very small depths within it; and is naturally formed into thin and flat cakes or crusts, which are of a spongy or cavernous substance, very light and friable, and, when pure, of a pale brownish white; but as its spongy texture renders it very subject to be fouled by earth received into its pores, it is often met with of a deep dirty brown, and not unfrequently reddish.

Natrum, whether native or purified, dissolves in a very small quantity of water; and this solution is, in many parts of Asia, used for washing; where it is also made into soap, by mixing it with oil. Natrum reduced to powder, and mixed with sand or flints, or with any other stone of which crystal is the basis, make them readily run into glass. Cold heated red-hot, and sprinkled with a small quantity of this salt, melts immediately; silver ignited and sprinkled with it, melts in the same manner; as does also iron, copper, and the regulus of antimony, which melt much more easily than they otherwise would do. Mercury will not be mixed with it by any art, and indeed will not amalgamate with metals if only a little of this salt be added. It is found in great abundance in many parts of Asia, where the natives sweep it up from the surface of the ground, and call it *sap-earth*. The earliest account we have of it is in the Scriptures, where we find that the salt called *nitre* in those times would ferment with vinegar, and had an absterfing quality, so that it was used in baths and in washing things. Solomon compares the singing of songs with a heavy heart, to the contrariety of vinegar and nitre; and Jeremiah says, that if the sinner wash himself with nitre, his sin is not cleansed off. These are properties that perfectly agree with this salt, but not at all with our salt-petre.

NATTER-JACK, in zoology, a species of RANA.

NATURAL, in general, something that relates to nature. See NATURE.

NATURAL Children, are those born out of lawful wedlock. See BASTARD.

NATURAL Functions, are those actions whereby the aliments are changed and assimilated so as to become



Natural. come a part of the body.

**NATURAL**, in heraldry, is used where animals, fruits, flowers, &c. are blazoned with the colours they naturally have, though different from the common colours of heraldry: and this is to prevent the armories being accused of falsity, when blazoned with the names of colours unknown in heraldry.

**NATURAL Note**, in music, is used in opposition to flat and sharp notes, which are called *artificial notes*. See **NOTE**, **SCALE**, &c.

**NATURAL** is also used for something coming im-

mediately out of the hands of nature: in which sense it stands opposed to *falsitious* or artificial, which signifies something wrought by art. See **ARTIFICIAL**.

Bishop Wilkins observes, that there appears a world of difference between natural and artificial things, when viewed with microscopes. The first ever appear adorned with all imaginable elegance and beauty; the latter, though the most curious in their kind, infinitely rude and unshewn: the finest needle appears a rough bar of iron; and the most accurate engraving or embossment as if done with a mattock or trowel.

Natural.

## N A T U R A L H I S T O R Y.

**NATURAL HISTORY**, is that science which not only gives complete descriptions of natural productions in general, but also teaches the method of arranging them into classes, orders, genera, and species. This definition includes zoology, botany, mineralogy, &c. But as a science so various and comprehensive could neither with propriety nor advantage be completely discussed under the general title, we have to refer the reader to the article **KINGDOMS** (*in Natural History*), where he will be directed to the different articles which constitute either the branches or the objects of the science, and which are all treated under their respective names.—In the present article it is proposed to give a general and philosophical view of the subject: To set forth, in a summary way, whatever curious, worthy to be known, or not obvious to every observer, occurs in the three kingdoms of nature: with their constitution, laws, and economy; or, in other words, that all-wise disposition of the Creator in relation to natural things, by which they are fitted to produce general ends and reciprocal uses.

### SECT. I. *Of the Terraqueous Globe in general, and its changes.*

THE world, or the terraqueous globe, which we inhabit, is every-where surrounded with elements, and contains in its superficies the three **KINGDOMS of Nature**, as they are called: the fossil, which constitutes the crull of the earth; the vegetable, which adorns the face of it, and draws the greatest part of its nourishment from the fossil kingdom; and the animal, which is sustained by the vegetable kingdom. Thus these three kingdoms cover, adorn, and vary the superficies of our earth.

As to the **STRATA of the EARTH and MOUNTAINS**, as far as we have hitherto been able to discover, the upper parts consist of rag-stone; the next of slate; the third of marble filled with petrifications; the fourth again, of slate; and lastly, the lowest of free-stone. The habitable part of the earth, though it is scooped into various inequalities, yet is every-where high in comparison with the water; and the farther it is from the sea, it is generally higher. Thus the waters in the lower places are not at rest, unless some obstacle confines them, and by that means form lakes and marshes.

THE **SEA** surrounds the continent, and takes up the greatest part of the earth's superficies, as **GEOGRAPHY** informs us. Nay, that it once spread over much the greatest part, we may be convinced by its yearly decrease, by the rubbish left by the tides, by shells, strata, and other circumstances.

The sea-shores are usually full of dead testaceous animals, wrack, and such like bodies, which are yearly thrown out of the sea. They are also covered with sand of various kinds, stones, and heaps of other things not very common. It happens, moreover, that while the more rapid rivers rush through narrow valleys, they wear away the sides; and thus the friable and soft earth falls in, and its ruins are carried to distant and winding shores; whence it is certain, that the continent gains no small increase, as the sea subsides.

THE **CLOUDS** collected from exhalations, chiefly from the sea, but likewise from other waters, and moist grounds, and condensed in the lower regions of the **ATMOSPHERE**, supply the earth with **RAIN**; but since they are attracted by the mountainous parts of the earth, it necessarily follows, that those parts must have, as is fit, a larger share of water than the rest. **SPRINGS**, which generally rush out at the foot of mountains, take their rise from this very rain-water and vapours condensed, that trickle through the holes and interstices of loose bodies, and are received into caverns.

These afford a pure **WATER** purged by straining; and rarely dry up in summer, or freeze in winter, so that animals never want a wholesome and refreshing liquor.

The chief sources of **RIVERS** are fountains and rills growing by gradual supplies into still larger and larger streams; till at last, after the conflux of a vast number of them, they find no stop, but falling into the sea with much rapidity, they there deposit the united stores they have gathered, along with foreign matter, and such earthy substances as they tore off in their way. Thus the water returns in a circle whence it first drew its origin, that it may act over the same scene again.

Marshes arising from water retained in low grounds are filled with mossy tumps, which are brought down by the water from the higher parts, or are produced by putrified plants.

We often see new meadows arise from marshes dried up. This happens sooner when the *sphagnum* (a kind of moss) has laid a foundation; for this in process of time changes into a very porous mould, till almost the whole marsh is filled with it. After that the rush strikes root, and along with the cotton-grasses constitutes a turf, raised in such a manner, that the roots get continually higher, and thus lay a more firm foundation for other plants, till the whole marsh is changed into a fine and delightful meadow; especially if the water happens to work itself a new passage.

Hillocks,

Hillocks, that abound in low grounds, occasion the earth to increase yearly, more than the countryman would wish, and seem to do hurt: but in this the great industry of nature deserves to be taken notice of. For by this means the barren spots become fooner rich meadow and pasture land. These hillocks are formed by the ant, by stones and roots, and the trampling of cattle: but the principal cause is the force of the winter-cold, which in the spring raises the roots of plants so high above the ground, that being exposed to the air, they grow, and perish; after which the golden maiden-hairs fill the vacant places.

Mountains, hills, valleys, and all the inequalities of the earth, though some think they take away much from its beauty, are so far from producing such an effect, as on the contrary they give a more pleasing aspect, as well as great advantages. For thus the terrestrial superficies is larger; different kinds of plants thrive better, and are more easily watered; and the rain-waters run in continual streams into the sea; not to mention many other uses in relation to winds, heat, and cold. Alps are the highest mountains, that reach to the second region of the air, where trees cannot grow erect. The higher these Alps are, the colder they are *ceteris paribus*. Hence the Alps in Sweden, Siberia, Switzerland, Peru, Brazil, Armenia, Asia, Africa, are perpetually covered with snow, which becomes almost as hard as ice. But if by chance the summer-heats be greater than ordinary, some part of these stores melts, and runs through rivers into the lower regions, which by this means are much refreshed.

It is scarcely to be doubted, but that the rocks and stones dispersed over the globe were formed originally in, and from, the earth; but when torrents of rain have softened, as they easily do, the soluble earth, and carried it down into the lower parts, we imagine it happens, that these solid and heavy bodies, being laid bare, slick out above the surface. We might also take notice of the wonderful effect of the tide, such as we see happen from time to time on the sea-shore, which being daily and nightly assaulted with repeated blows, at length gives way, and breaks off. Hence we see in moist places the rubbish of the sea, and shores.

The winter by its froit prepares the earth and mould, which thence are broken into very minute particles, and thus, being put into a mouldering state, become more fit for the nourishment of plants; nay, by its snow it covers the seeds, and roots of plants, and thus by cold defends them from the force of cold. We must add also, that the piercing froit of the winter purifies the atmosphere and putrid waters, and makes them more wholesome for animals.

The perpetual succession of heat and cold with us renders the summers more pleasing: and tho' the winter deprives us of many plants and animals, yet the perpetual summer within the tropics is not much more agreeable, as it often destroys men and other animals by its immoderate heat; though it must be confessed, that those regions abound with exquisite fruits. Our winters, though very troublesome to a great part of the globe on account of their vehement and intense cold, yet are less hurtful to the inhabitants of the northern parts, as experience testifies. Hence it hap-

pens, that we may live very conveniently on every part of the earth, as every different country has different advantages from nature.

THE seasons, like every thing else, have their vicissitudes; their beginnings, their progress, and their end.

The age of man begins from the cradle; pleasing childhood succeeds; then active youth; afterwards manhood, firm, severe, and intent upon self-preservation; lastly, old age creeps on, debilitates, and at length totally destroys our tottering bodies.

The seasons of the year proceed in the same way. Spring, the jovial, playful infancy of all living creatures, represents childhood and youth; for then plants spread forth their luxuriant flowers, fishes exult, birds sing, every part of nature is intent upon generation. The summer, like middle age, exhibits plants, and trees every-where clothed with green; it gives vigour to animals, and plumps them up; fruits then ripen, meadows look cheerful, every thing is full of life. On the contrary, autumn is gloomy; for then the leaves of trees begin to fall, plants to wither, insects to grow torpid, and many animals to retire to their winter-quarters.

The day proceeds with just such steps, as the year. The morning makes every thing alert, and fit for business: the sun pours forth his ruddy rays; the flowers, which had as it were slept all night, awake and expand themselves again; the birds with their sonorous voices and various notes make the woods ring, meet together in flocks, and sacrifice to Venus. Noon tempts animals into the fields and pastures; the heat puts them upon indulging their ease, and even necessity obliges them to it. Evening follows, and makes every thing more sluggish; flowers shut up\*, and animals retire to their lurking places. Thus the spring, the morning, and youth, are proper for generation; the summer, noon, and manhood, are proper for preservation; and autumn, evening, and old age, are not unfitly likened to destruction.

In order to perpetuate the established course of nature, in a continued series, the Divine Will had thought fit that all living creatures should constantly be employed in producing individuals; that all natural things should contribute and lend a helping hand towards preserving every species; and lastly, that the death and destruction of one thing should always be subservient to the production of another. Hence the objects of our present inquiry fall to be considered in a threefold view, that of propagation, preservation, and death or destruction.

## SECT. II. *The Fossil Kingdom.*

### I. PROPAGATION.

IT is agreed on all hands, that stones are not organic bodies, like plants and animals; and therefore it is as clear that they are not produced from an egg, like the tribes of the other kingdoms. Hence the variety of fossils is proportionate to the different combinations of coalescent particles, and hence the species in the fossil kingdom are not so distinct as in the other two. Hence also the laws of generation in relation

\* See  
VIGILS of  
Plants.

Fossil Kingdom.

Fossil Kingdom.

relation to fossils have been in all ages extremely difficult to explain; and lastly, hence have arisen so many different opinions about them, that it would be endless to enumerate them all. We therefore for the present will content ourselves with giving a very few observations on this subject.

That clay is the sediment of the sea is sufficiently proved by observation, for which reason it is generally found in great plenty along the coasts.

The journals of seamen clearly evince, that a very minute sand covers the bottom of the sea; nor can it be doubted, but that it is daily crystallized out of the water.

It is now acknowledged by all, that testaceous bodies and petrifications resembling plants were once real animals or vegetables; and it seems likely that shells, being of a calcareous nature, have changed the adjacent clay, sand, or mould, into the same kind of substance. Hence we may be certain that marble may be generated from petrifications; and therefore it is frequently seen full of them.

Rag-stone, the common matter of our rocks, appears to be formed from a sandy kind of clay; but this happens more frequently where the earth is impregnated with iron.

Free-stone is a product of sand; and the deeper the bed where it is found, the more compact it becomes; and the more dense the sand, the more easily it concretes. But if an alkaline clay chances to be mixed with the sand, the free-stone is generated more readily, as in the free-stone called *cor friatilis*, *particulis argillo-glaveris*.

The flint is almost the only kind of stone, certainly the most common stone, in chalky mountains. It seems therefore to be produced from chalk. Whether it can be reduced again to chalk, is left to others to inquire.

Stalactites, or drop-stone, is composed of calcareous particles, adhering to a dry, and generally a vegetable body.

Incrustations (*Syst. Nat.* 32. 5, 6, 7, 8.) are often generated, where a vitriolic water connects clayey and earthy particles together.

Slate, by the vegetables that are often inclosed in it, seems to take its origin from a marshy mould.

Metals vary according to the nature of the matrix in which they adhere; e. g. the pyrites cupri Falunensis contains frequently sulphur, arsenic, iron, copper, a little gold, vitriol, alum, sometimes lead-ore, silver, and zinc. Thus gold, copper, iron, zinc, arsenic, pyrites, vitriol, come out of the same vein. That very rich iron-ore at Normark in Vermilandia, where it was cut transversely by a vein of clay, was changed into pure silver. The number therefore of species and varieties of fossils, each serving for different purposes according to their different natures, will be in proportion as the different kinds of earths and stones are variously combined.

## II. PRESERVATION.

As fossils are destitute of life and organization, are hard, and not obnoxious to putrefaction; so they last longer than any other kind of bodies. How far the air contributes to this duration, it is easy to perceive; since air hardens many stones upon the su-

perficies of the earth, and makes them more solid, compact, and able to resist the injuries of time. Thus it is known from vulgar observation, that lime, that has been long exposed to the air, becomes hardened. The chalky marl which they use in Flanders for building houses, as long as it continues in the quarry is friable, but when dug up and exposed to the air it grows gradually harder.

However ignorant we may be of the cause why large rocks are every-where to be seen split, whence vast fragments are frequently torn off; yet this we may observe, that fissures are closed up by water, which gets between them, and is detained there, and are consolidated by crystal and spar. Hence we scarcely ever find any crystal, but in those stones which have retained for some time in its clinks water loaded with stony particles. In the same manner crystals fill the cavities in mines, and concrete into quartz or a debased crystal.

It is manifest that stones are not only generated, augmented, and changed perpetually, from incrustations brought upon moss, but are also increased by crystal, and spar. Not to mention that the adjacent earth, especially if it be impregnated with iron particles, is commonly changed into a solid stone.

It is said, that the marble quarries in Italy, from whence fragments are cut, grow up again. Ores grow by little and little, whenever the mineral particles, conveyed by the means of water through the clefts of mountains, are retained there; so that, adhering to the homogeneous matter a long while, at last they take its nature, and are changed into a similar substance.

## II. DESTRUCTION.

Fossils, although they are the hardest of bodies, yet are found subject to the laws of destruction, as well as all other created substances. For they are dissolved in various ways by the elements exerting their force upon them; as by water, air, and the solar rays; as also by the rapidity of rivers, violence of cataracts, and eddies, which continually beat upon, and at last reduce to powder the hardest rocks. The agitations of the sea, and lakes, and the vehemency of the waves, excited by turbulent winds, pulverise stones, as evidently appears by their roundness along the shore. Nay, as the poet says,

The hardest stone insensibly gives way  
To the soft drops that frequent on it play.

So that we ought not to wonder, that these very hard bodies moulder away into powder, and are obnoxious like others to the consuming tooth of time.

Sand is formed of free-stone, which is destroyed partly by frost, making it friable; partly by the agitation of water and waves, which easily wear away, dissolve, and reduce into minute particles, what the frost had made friable.

Chalk is formed of rough marble, which the air, the sun, and the winds, have dissolved.

The slate-earth, or humus schisti, (*Syst. Nat.* 512.) owes its origin to slate, showers, air, and snow melted.

Ochre is formed of metals dissolved, whose fæces present the very same colours which we always find  
the

the ore tinged with when exposed to the air. Vitriol in the same manner mixes with water from ore destroyed.

The *muria faxatilis*, (*Syf. Nat.* 14. 6.) a kind of talky stone, yielding salt in the parts that are turned to the sun, is dissolved into sand, which falls by little and little upon the earth, till the whole is consumed; not to mention other kinds of fossils. Lastly, from these there arise new fossils, as we mentioned before; so that the destruction of one thing serves for the generation of another.

Tefaceous worms ought not to be passed over on this occasion, for they eat away the hardest rocks. That species of shell-fish called the *razor-shell* bores through stones in Italy, and hides itself within them; so that the people who eat them are obliged to break the stones before they can come at them. The cochlea, (*Fawn. Succ.* 1299.) a kind of snail that lives on craggy rocks, eats and bores through the chalky hills, as worms do through wood. This is made evident by the observations of the celebrated de Geer.

### SECT. III. *The Vegetable Kingdom.*

#### I. PROPAGATION.

ANATOMY abundantly proves, that all plants are organic and living bodies; and that all organic bodies are propagated from an egg has been sufficiently demonstrated by the industry of the moderns. We therefore the rather, according to the opinion of the skilful, reject the equivocal generation of plants; and the more so, as it is certain that every living thing is produced from an egg. Now the seeds of vegetables are called *eggs*; these are different in every different plant, that the means being the same, each may multiply its species, and produce an offspring like its parent. We do not deny, that very many plants push forth from their roots fresh offsets for two or more years. Nay, not a few plants may be propagated by branches, buds, suckers, and leaves, fixed in the ground, as likewise many trees. Hence their stems being divided into branches, may be looked on as roots above ground; for in the same way the roots creep under ground, and divide into branches. And there is the more reason for thinking so, because we know that a tree will grow in an inverted situation, viz. the roots being placed upwards, and the head downwards, and buried in the ground; for then the branches will become roots, and the roots will produce leaves and flowers. The lime-tree will serve for an example, on which gardeners have chiefly made the experiment. Yet this by no means overturns the doctrine, that all vegetables are propagated by seeds; since it is clear that in each of the foregoing instances nothing vegetates but what was the part of a plant, formerly produced from seed; so that, accurately speaking, without seed no new plant is produced.

Thus again plants produce seeds; but they are entirely unfit for propagation, unless fecundation precedes, which is performed by an intercourse between different sexes, as experience testifies. Plants therefore must be provided with organs of generation; in which respect they hold an analogy with animals. Since in every plant the flower always precedes the fruit, and the fecundated seeds visibly arise from the

fruit; it is evident that the organs of generation are contained in the flower, which organs are called *antheræ* and *stigmata*, and that the impregnation is accomplished within the flower. This impregnation is performed by means of the dust of the antheræ falling upon the moist stigmata, where the dust adheres, is burst, and sends forth a very bulky matter, which is absorbed by the style, and is conveyed down to the rudiments of the seed, and thus renders it fertile. When this operation is over, the organs of generation wither and fall, nay a change in the whole flower ensues. We must however observe, that in the vegetable kingdom one and the same flower does not always contain the organs of generation of both sexes, but oftentimes the male organs are on one plant, and the female on another. But that the business of impregnation may go on successfully, and that no plant may be deprived of the necessary dust, the whole most elegant apparatus of the antheræ and stigmata in every flower is contrived with wonderful wisdom.

For in most flowers the stamina surround the pistils, and are of about the same height: but there are many plants in which the pistil is longer than the stamina; and in these it is wonderful to observe, that the Creator has made the flowers recline, in order that the dust may more easily fall into the stigma; e. g. in the campanula, cowslip, &c. This curious phenomenon did not escape the poetical eye of Milton, who describes it in the following enlivened imagery:

With cowslips wan, that hang the pensive head.

But when the fecundation is completed, the flowers rise again, that the ripe seeds may not fall out before they are dispersed by the winds. In other flowers, on the contrary, the pistil is shorter, and there the flowers preserve an erect situation; nay, when the flowering comes on, they become erect, though before they were drooping, or immersed under water. Lastly, whenever the male flowers are placed below the female ones, the leaves are exceedingly small and narrow, that they may not hinder the dust from flying upwards like smoke; as we see in the pine, fir, yew, sea-grape, juniper, cyprès, &c. And when in one and the same species one plant is male and the other female, and consequently may be far from one another, there the dust, without which there is no impregnation, is carried in abundance by the help of the wind from the male to the female; as in the whole dioicous class. Again, a more difficult impregnation is compensated by the longevity of the individuals, and the continuation of life by buds, suckers, and roots; so that we may observe every thing most wisely disposed in this affair. Moreover, we cannot without admiration

observe that most flowers expand themselves when the sun shines forth; whereas when clouds, rain, or the evening comes on, they close up, lest the genital dust should be coagulated, or rendered useless, so that it cannot be conveyed to the stigmata. But what is still more remarkable and wonderful, when the fecundation is over, the flowers, neither upon showers, nor evening coming on, close themselves up. Hence when rain falls in the flowering time, the husbandman and gardener foretel a scarcity of fruits. To mention only one particular more: The organs of generation, which in the animal kingdom are by nature generally removed from sight, in the vegetable are exposed to the eyes

Vid. a Treatise published in the *Annals of the Royal Academy of Sciences*, vol. 17, p. 100. *Antiquities of the Royal Academy of Sciences*, p. 100. *Plantarum*.

eyes of all; and that when their nuptials are celebrated, it is wonderful what delight they afford to the spectator by their most beautiful colours and delicious odours. At this time bees, flies, and other insects, suck honey out of their nectaries, not to mention the humming bird; and that from their effete dull the bees gather wax.

2. As to the dissemination of seeds after they come to maturity, it being absolutely necessary, since without it no crop could follow, the Author of nature has wisely provided for this affair in numberless ways. The stalks and stems favour this purpose; for these raise the fruit above the ground, that the winds, shaking them to and fro, may disperse far off the ripe seeds. Most of the pericarps are shut at top, that the seeds may not fall before they are shook out by stormy winds. Wings are given to many seeds, by the help of which they fly far from the mother-plant, and oftentimes spread over a whole country. These wings consist either of a down, as in most of the composite-flowered plants; or of a membrane, as in the birch, alder, ash, &c. Hence woods, which happen to be consumed by fire or any other accident, will soon be restored again by new plants disseminated by this means. Many kinds of fruits are endued with a remarkable elasticity, by the force of which the ripe pericarps throw the seeds to a great distance; as the wood-sorrel, the spurge, the phyllanthus, the dittany. Other seeds or pericarps are rough, or provided with hooks; so that they are apt to stick to animals that pass by them, and by this means are carried to their holes, where they are both sown and manured by nature's wonderful care: and therefore the plants of these seeds grow where others will not; as hounds-tongue, agrimony, &c.

Berries and other pericarps are by nature allotted for aliment to animals; but with this condition, that while they eat the pulp they shall sow the seeds: for when they feed upon it, they either disperse them at the same time; or, if they swallow them, they are returned with interest, for they always come out unhurt. It is not therefore surprising, that, if a field be manured with recent mud or dung not quite rotten, various other plants, injurious to the farmer, should come up along with the grain that is sowed. Many have believed that barley or rye has been changed into oats, although all such kinds of metamorphoses are repugnant to the laws of generation; not considering that there is another cause of this phenomenon, viz. that the ground perhaps has been manured with horse-dung, in which the seeds of oats, coming entire from the horse, lie hid and produce that grain. The milletce always grows upon other trees, because the thrush that eats the seeds of it, casts them forth with its dung; and as bird-catchers make their bird-lime of this same plant, and daub the branches of trees with it, in order to catch the thrush, the proverb hence took its rise;

The thrush, when he befalls the bough,  
Sows for himself the seeds of wo.

It is not to be doubted, but that the greatest part of the junipers also, that fill our woods, are sown by thrushes, and other birds, in the same manner; as the berries, being heavy, cannot be dispersed far by the winds. The cross-bill that lives on the fir-cones, and the hawfinch that feeds on the pine-cones, at the same

time sow many of their seeds; especially when they carry the cone to a stone, or trunk of a tree, that they may more easily strip it of its scales. Swine likewise, by turning up the earth, and moles by throwing up hillocks, prepare the ground for seeds in the same manner as the ploughman does.

We pass over many other things which might be mentioned concerning the sea, lakes, and rivers, by the help of which oftentimes feeds are conveyed unhurt to distant countries. A variety of other ways in which nature provides for the dissemination of plants, has been pointed out by Linnæus in an *Oration concerning the augmentation of the habitable earth*. As there is something very ingenious and quite new in the treatise here referred to, we shall, for the sake of those who cannot read the original, add a short abstract of it. His design is to shew that there was only one pair of all living things, created at the beginning. According to the account of Moses, says the author, we are sure that this was the case in the human species; and by the same account we are informed that this first pair was placed in Eden, and that Adam gave names to all the animals. In order therefore that Adam might be enabled to do this, it was necessary that all the species of animals should be in in paradise; which could not happen unless also all the species of vegetables had been there likewise. This he proves from the nature of their food; particularly in relation to insects, most of which live upon one plant only. Now had the world been formed in its present state, it could not have happened that all the species of animals should have been there. They must have been dispersed over all the globe, as we find they are at present; which he thinks improbable for other reasons which we shall pass over for sake of brevity. To solve all the phenomena, then, he lays down as a principle, That at the beginning all the earth was covered with the sea, unless one island large enough to contain all animals and vegetables. This principle he endeavours to establish by several phenomena, which make it probable, that the earth has been and is still gaining upon the sea, and does not forget to mention fossil shells and plants every where found, which he says cannot be accounted for by the deluge. He then undertakes to shew how all vegetables and animals might in this island have a soil and climate proper for each, only by supposing it to be placed under the equator, and crowned with a very high mountain. For it is well known that the same plants are found on the Swiss, the Pyrenean, the Scots Alps, on Olympus, Lebanon, Ida, as on the Lapland and Greenland Alps. And Tournefort found at the bottom of mount Ararat the common plants of Armenia, a little way up those of Italy, higher those which grow about Paris, afterwards the Swedish plants, and lastly on the top the Lapland Alpine plants; and I myself, adds the author, from the plants growing on the Dalecarlian Alps could collect how much lower they were than the Alps of Lapland. He then proceeds to shew how from one plant of each species the immense number of individuals now existing might arise. He gives some instances of the surprising fertility of certain plants; v. g. the elecampane, one plant of which produced 3000 seeds; of spelt, 2000; of the sun-flower, 4000; of the poppy, 3200; of tobacco, 40,320. But supposing any annual plant producing yearly only two

feeds, even of this, after 20 years, there would be 1,048,576 individuals. For they would increase yearly in a duplicate proportion, viz. 2, 4, 8, 16, 32, &c. He then gives some instances of plants brought from America, that are now become common over many parts of Europe. Lastly, he enters upon a detail of the several methods which nature has taken to propagate vegetables, which is extremely curious, but too long to insert in this place.

## II. PRESERVATION.

1. THE great Author and Parent of all things decreed, that the whole earth should be covered with plants, and that no place should be void, none barren. But since all countries have not the same changes of seasons, and every soil is not equally fit for every plant; he therefore, that no place should be without some, gave to every one of them such a nature, as might be chiefly adapted to the climate: so that some of them can bear an intense cold, others an equal degree of heat; some delight in dry ground, others in moist, &c. Hence the same plants grow only where there are the same seasons of the year, and the same soil.

The Alpine plants live only in high and cold situations; and therefore often on the Alps of Armenia, Switzerland, the Pyreneans, &c. whose tops are equally covered with eternal snows as those of the Lapland Alps, plants of the same kind are found, and it would be in vain to seek for them any where else. It is remarkable, in relation to the Alpine plants, that they blow, and ripen their seeds very early, lest the winter should steal upon them on a sudden, and destroy them.

Our northern plants, altho' they are extremely rare every where else, yet are found in Siberia, and about Hudson's bay; as the arbutus, bramble, winter-green, &c.

Plants impatient of cold live within the torrid zones; hence both the Indies, though at such a distance from one another, have plants in common. The Cape of Good Hope, we know not from what cause, produces plants peculiar to itself; as all the mesembryanthea, and almost all the species of aloes. Grasses, the most common of all plants, can bear almost any temperature of air: in which the good providence of the Creator particularly appears; for all over the globe they, above all plants, are necessary for the nourishment of cattle; and the same thing is seen in relation to our most common grains.

Thus neither the scorching sun, nor the pinching cold, hinders any country from having its vegetables. Nor is there any soil which does not bring forth many kinds of plants. The pond-weeds, the water-lily, lobelia, inhabit the waters. The fluviatiles, fuci, confervæ, fill the marshes. The bryæ † clothe the plains. The driest woods, and places scarce ever illuminated by the rays of the sun, are adorned with the hypnæ. Nay, stones and the trunks of trees are not excepted, for these are covered with various kinds of liverwort.

The desart, and most sandy places, have their peculiar trees and plants; and as rivers or brooks are very seldom found there, we cannot without wonder observe that many of them distil water, and by that means afford the greatest comfort both to man and beasts that travel there. Thus the tillandsia\*, which is a parasitical plant, and grows on the tops of trees in the desarts

of America, has its leaves turned at the base into the shape of a pitcher, with the extremity expanded; in these the rain is collected, and preserved for thirsty men, birds, and beasts.

The water-tree in Ceylon produces cylindrical bladders, covered with a lid; into these is secreted a most pure and refreshing water, that tastes like nectar to men and other animals. There is a kind of cuckoo-pint in New France, that, if you break a branch of it, will afford you a pint of excellent water. How wise, how beautiful, is the agreement between the plants of every country, and its inhabitants, and other circumstances!

2. Plants oftentimes by their very structure contribute remarkably both to their own preservation and that of others. But the wisdom of the Creator appears no where more, than in the manner of growth of trees. For as their roots defend deeper than those of other plants provision is thereby made, that they shall not rob them too much of nourishment; and what is still more, a stem not above a span in diameter often shoots up its branches very high; these bear perhaps many thousand buds, each of which is a plant, with its leaves, flowers, and stipule. Now if all these grew upon the plain, they would take up a thousand times as much space as the tree does; and in this case there would scarcely be room in all the earth for so many plants, as at present the trees alone afford. Besides, plants that shoot up in this way are more easily preserved from cattle by a natural defence; and farther, their leaves falling in autumn cover the plants growing about against the rigour of the winter, and in the summer they afford a pleasing shade, not only to animals, but to plants, against the intense heat of the sun. We may add, that trees, like all other vegetables, imbibe the water from the earth, which water does not circulate again to the root, as the ancients imagined; but being diffused, like small rain, by the transpiration of the leaves, moistens the plants that grow around. Again, many trees bear fleshy fruits of the berry or apple kind, which, being secure from the attack of cattle, grow ripe for the use of man and other animals, while their seeds are dispersed up and down after digestion. Lastly, the particular structure of trees contributes very much to the propagation of insects; for these chiefly lay their eggs upon the leaves, where they are secure from the reach of cattle.

Ever-green trees and shrubs in the northern parts are chiefly found in the most barren woods, that they may be a shelter to animals in the winter. They lose their leaves only every third year, as their seeds are sufficiently guarded by the mosses, and do not want any other covering. The palms in the hot countries perpetually keep their leaves, for there the seeds stand in no need of any shelter whatever.

Many plants and shrubs are armed with thorns, e.g. the buck-horn, sloe, carduus, cotton-thistle, &c. that they may keep off the animals, which otherwise would destroy their fruit. These at the same time cover many other plants, especially of the annual kind, under their branches. Nay, it has frequently been observed upon commons where furze grows, that wherever there was a bush left untouched for years by the commoners, some tree has sprung up, being secured by the prickles of that shrub from the bite of cattle. So that while the adjacent grounds are robbed of all plants by the voracity

† A kind of moss.  
‡ Another kind of moss.

\* A kind of milk-toc.

voracity of animals, some may be preserved to ripen flowers and fruit, and flock the parts about with feeds, which otherwise would be quite extirpated.

All herbs cover the ground with their leaves, and by their shade hinder it from being totally deprived of that moisture which is necessary to their nourishment. They are moreover an ornament to the earth, especially as leaves have a more agreeable verdure on the upper than the under side.

The mosses which adorn the most barren places, at the same time preserve the lesser plants when they begin to shoot, from cold and drought: As we find by experience in our gardens, that plants are preserved in the same way. They also hinder the fermenting earth from forcing the roots of plants upwards in the spring; as we see happen annually to trunks of trees, and other things put into the ground. Hence very few mosses grow in the warmer climates, as not being so necessary to that end in those places.

The English sea mat-weed, or marran, will bear no soil but pure sand, which nature has allotted to it. Sand, the produce of the sea, is blown by winds oftentimes to very remote parts, and deluges, as it were, woods and fields. But where this grass grows, it frequently fixes the sand, gathers it into hillocks, and thrives so much, that, by means of this alone, at last an entire hill of sand is raised. Thus the sand is kept in bounds, other plants are preserved free from it, the ground is increased, and the sea is repelled by this wonderful disposition of nature.

How foliaceous nature is about the preservation of grasses is abundantly evident from hence, that the more the leaves of the perennial grasses are eat, the more they creep by the roots, and send forth offsets. For the Author of nature intended that vegetables of this kind, which have very slender and erect leaves, should be copious, and very thick-set, covering the ground like a carpet; and thus afford food sufficient for so vast a quantity of grazing animals. But what chiefly increases our wonder is, that although the grasses are the principal food of such animals, yet they are forbid as it were to touch the flower and seed-bearing stems, that so the seeds may ripen and be sown.

The caterpillar or grub of the moth, although it feeds upon grasses, to the great destruction of them in meadows, yet it seems to be formed in order to keep a due proportion between these and other plants: for grasses, when left to grow freely, increase to that degree, that they exclude all other plants; which would consequently be extirpated, unless this insect sometimes prepared a place for them. Hence always more species of plants appear in those places where this caterpillar has laid waste the pastures the preceding year, than at any other time.

### III. DESTRUCTION.

DAILY experience teaches us, that all plants, as well as all other living things, must submit to death.

They spring up, they grow, they flourish, they ripen their fruit, they wither, and at last, having finished their course, they die, and return to the dust again, from whence they first took their rise. Thus all black mould, which every where covers the earth, for the greatest part is owing to dead vegetables. For all roots descend into the sand by their branches, and after a

plant has lost its stem the root remains; but this too rots at last, and changes into mould. By this means this kind of earth is mixed with sand, by the contrivance of nature, nearly in the same way as dung thrown upon fields is wrought into the earth by the industry of the husbandman. The earth thus prepared offers again to plants from its bosom, what it has received from them. For when feeds are committed to the earth, they draw to themselves, accommodate to their nature, and turn into plants, the more subtile parts of this mould by the co-operation of the sun, air, clouds, rains, and winds; so that the tallest tree is, properly speaking, nothing but mould wonderfully compounded with air and water, and modified by a virtue communicated to a small seed by the Creator. From these plants, when they die, just the same kind of mould is formed as gave birth to them originally; but in such a manner, that it is in greater quantity than before. Vegetables therefore increase the black mould, whence fertility remains continually uninterrupted. Whereas the earth could not make good its annual consumption, unless it were constantly recruited by new supplies.

The crustaceous liverworts are the first foundation of vegetation; and therefore are plants of the utmost consequence in the oeconomy of nature, tho' so despised by us. When rocks first emerge out of the sea, they are so polished by the force of the waves, that scarce any herb can find a fixed habitation upon them; as we may observe every where near the sea. But the very minute crustaceous liverworts begin soon to cover these dry rocks, although they have no other nourishment but that small quantity of mould and imperceptible particles which the rain and air bring thither. These liverworts dying at last turn into a very fine earth; on this earth the imbricated liverworts find a bed to strike their roots in. These also die after a time, and turn to mould; and then the various kinds of mosses, e. g. the hypna, the brya, polytricha, find a proper place and nourishment. Lastly, these dying in their turn, and rotting, afford such plenty of new-formed mould, that herbs and shrubs easily root and live upon it.

That trees, when they are dry or are cut down, may not remain useless to the world, and lie as it were melancholy spectacles, nature has given on their destruction in a singular way: first the liverworts begin to strike root in them; afterwards the moisture is drawn out of them; whence putrefaction follows. Then the mushroom kinds find a fit place for nourishment on them, and corrupt them still more. The beetle called the *dermestes*, next makes himself a way between the bark and the wood. The musk-beetle, the copper talc-beetle, and the caterpillar or *coffus* 812 (*S. N.*) bores an infinite number of holes through the trunk. Lastly, the woodpeckers come, and, while they are seeking for insects, wear away the tree already corrupted; till the whole passes into earth. Such industry does nature use to destroy the trunk of a tree! Nay, trees immersed in water would scarcely ever be destroyed, were it not for the worm that eats ships, which performs this work; as the sailor knows by sad experience.

Thistles, as the most useful of plants, are armed, and guarded by nature herself. Suppose there were a

heap of clay, on which for many years no plant has sprung up; let the seeds of the thistle blow there, and grow, the thistles by their leaves attract the moisture out of the air, send it into the clay by means of their roots, will thrive themselves, and afford a shade. Let now other plants come hither, and they will soon cover the ground. *St Bicke.*

All succulent plants make ground fine, of a good quality, and in great plenty; as sedum, crassula, aloë, algæ. But dry plants make it more barren, as heath, pines, moss; and therefore nature has placed the succulent plants on rocks, and the driest hills.

#### SECT. IV. *The Animal Kingdom.*

##### I. PROPAGATION.

1. THE generation of animals holds the first place among all things that raise our admiration when we consider the works of the Creator; and chiefly that appointment, by which he has regulated the conception of the fœtus, and its exclusion, that it should be adapted to the disposition and way of living of each animal, is most worthy of our attention.

We find no species of animals exempt from the stings of love, which is put into them to the end that the Creator's mandate may be executed, *Increase and multiply*; and that thus the egg, in which is contained the rudiment of the fœtus, may be fecundated; for without fecundation all eggs are unfit to produce an offspring.

Foxes and wolves, struck with these stings, every where howl in the woods; crowds of dogs follow the female; bulls shew a terrible countenance, and very different from that of oxen. Stags every year have new horns, which they lose after rutting time. Birds look more beautiful than ordinary, and warble all day long through lasciviousness. Thus small birds labour to outdo one another, and cocks to outcrow. Peacocks spread forth again their gay and glorious trains. Fishes gather together, and exult in the water; and grasshoppers chirp, and pipe, as it were, amongst the herbs. The ants gather again into colonies, and repair to their citadels. We pass over many other particulars, which this subject affords, to avoid prolixity.

2. The fecundated egg requires a certain and proportionate degree of heat for the expansion of the stamina of the embryo. That this may be obtained, nature operates in different manners; and therefore we find in different classes of animals a different way of excluding the fœtus.

The females of quadrupeds have an uterus, contrived for easy gestation, temperate and cherishing warmth, and proper nourishment of the fœtus, as most of them live upon the earth, and are there fed.

Birds, in order to get subsistence, and for other reasons, are under a necessity of shifting place; and that not upon their feet, but wings. Gestation therefore would be burthenfome to them. For this reason they lay eggs, covered with a hard shell. These they sit upon by a natural instinct, and cherish till the young one comes forth.

The otlich and cassowary are almost the only birds that do not observe this law; these commit their eggs to the sand, where the intense heat of the sun excludes the fœtus.

Fishes inhabit cold waters, and most of them have cold blood; whence it happens that they have not heat sufficient to produce the fœtus. The all-wise Creator therefore has ordained, that most of them should lay their eggs upon the shore; where, by means of the solar rays, the water is warmer, and also fitter for that purpose; because it is there less impregnated with salt, and consequently milder; and also because water-insects abound more there, which afford the young fry nourishment.

Salmons in the like manner, when they are about to lay their eggs, are led by instinct to go up the stream, where the water is fresh and more pure.

The butterfly-fish is an exception, for that brings forth its fœtus alive.

The fishes of the ocean, which cannot reach the shores by reason of the distance, are also exempt from this law. The Author of nature has given to this kind eggs that swim; so that they are batched amidst the swimming fucus, called *fargazo*\*.

The cetaceous fish have warm blood; and therefore they bring forth their young alive, and suckle them with their teats. \* Flor. Zeyl. 389.

Many amphibious animals bring forth live fœtuses, as the viper and the toad, &c. But the species that lay eggs, lay them in places where the heat of the sun supplies the warmth of the parent.

Thus the rest of the frog kind, and the lizard kind, lay their eggs in warm waters; the common snake in dunghills, and such like warm places; and give them up to nature, as a provident nurse, to take care of them. The crocodile and sea-tortoises go ashore to lay their eggs under the sand, where the heat of the sun hatches them.

Most of the insect kind neither bear young nor hatch eggs: yet their tribes are the most numerous of all living creatures; inasmuch that if the bulk of their bodies were proportionate to their quantity, they would scarce leave room for any other kinds of animals. Let us see therefore with what wisdom the Creator has managed about the propagation of these minute creatures. The females by natural instinct meet and copulate with the males; and afterwards lay their eggs: but not indiscriminately in every place. For they all know how to choose such places as may supply their offspring in its tender age with nourishment, and other things necessary to satisfy their natural wants: for the mother, soon after she has laid her eggs, dies; and were she to live, she would not have it in her power to take care of her young.

Butterflies, moths, some beetles, weevils, bugs, cuckoo-spit insects, gall-insects, tree-bugs, &c. lay their eggs on the leaves of plants, and every different tribe chooses its own species of plant. Nay, there is scarce any plant which does not afford nourishment to some insect; and still more, there is scarcely any part of a plant which is not preferred by some of them. Thus one insect feeds upon the flower; another upon the trunk; another upon the root; and another upon the leaves. But we cannot help wondering particularly, when we see how the leaves of some trees and plants, after eggs have been let into them, grow into galls; and form dwellings, as it were, for the young ones, where they may conveniently live. Thus when the gall-insect has fixed her eggs in the leaves of an oak, the

would



wound of the leaf swells, and a knob like an apple arises, which includes and nourishes the embryo.

When the tree-bug has deposited its eggs in the boughs of the fir-tree, excrescences arise shaped like pearls. When another species of the tree-bug has deposited its eggs in the moufe-ear chickweed or the speedwell, the leaves contract in a wonderful manner into the shape of a head. The water-spider, excludes eggs either on the extremities of the juniper, which from thence forms a lodging, that looks like the arrow-headed grass; or on the leaves of the poplar, from whence a red globe is produced. The tree-louse lays its eggs on the leaves of the black poplar, which upon that turn into a kind of inflated bag; and so in other instances. Nor is it upon plants only that insects live and lay their eggs. The gnats commit theirs to flag-nating waters. The water-insect called *monoculus* often increases fo immensely on pools, that the red legions of them have the appearance of blood. Others lay their eggs in other places: e.g. the beetle, in dung-hills; the dermestes, in skins; the fish-fly, in putrified flesh; the cheese-maggot, in the cracks of cheese, from whence the caterpillars issuing forth, oftentimes consume the whole cheese, and deceive many people, who fancy the worms are produced from the particles of the cheese itself, by a generation called *equivocal*, which is extremely absurd. Others exclude their eggs upon certain animals. The mill-beetle lays its eggs between the scales of fishes; the species of gad-fly, on the back of cattle; the species 1025 (*S. N.*) on the back of the rein-deer; the species 1026, in the noses of sheep. The species 1028 lodges during the winter in the intestinal tube, or the throat of horses, nor can it be driven out till the summer comes on. Nay, insects themselves are often surrounded with the eggs of other insects, inso much that there is scarcely an animal to be found which does not feed its proper insect, not to say any more of all the other places where they deposit their eggs. Almost all the eggs of insects, when laid, are ordained to undergo, by a wonderful law of nature, various metamorphoses, e.g. the egg of the butterfly, being laid in the cabbage, first of all becomes a caterpillar, that feeds upon grass, crawls, and has 16 feet. This afterwards changes into a nymph, that has no feet, is smooth, and eats nothing; and lastly, this bursts into a butterfly that flies, has variety of colours, is rough, and lives upon honey. What can be more worthy of admiration than that one and the same animal should appear on the stage of life under so many characters, as if it were three distinct animals. Linnæus, (*Ann. Acad. tom. ii.*) in a treatise on the wonders relating to insects, says, "As surprising as these transformations may seem, yet much the same happens when a chicken is hatched; the only difference is, that this chicken breaks all three coats at once, the butterfly one after another."

The laws of generation of worms are still very obscure; as we find they are sometimes produced by eggs, sometimes by offsets just in the same manner as happens to trees. It has been observed with the greatest admiration, that the polypos or hydra (*S. N. 221.*) lays down shoots and live branches, by which it is multiplied. Nay more, if it be cut into many parts, each segment, put into the water, grows into a perfect animal; so that the parts which were torn off are re-

stored from one scrap.

3. The multiplication of animals is not tied down to the same rules in all; for some have a remarkable power of propagating, others are confined within narrower limits in this respect. Yet in general we find, that nature observes this order, that the least animals, and those which are useful and serve for nourishment to the greatest number of other animals, are endued with a greater power of propagating than others.

Mites, and many other insects, will multiply to a thousand within the compass of a very few days; while the elephant scarcely produces one young in two years.

The hawk kind generally lay not above two eggs, at most four; while the poultry kind rises to 50.

The diver, or loon, which is eaten by few animals, lays also two eggs; but the duck kind, the moor-game, partridges, &c. and small birds, lay a very large number.

If you suppose two pigeons to hatch nine times a-year, they may produce in four years 14760 young. They are endued with this remarkable fertility, that they may serve for food, not only to man, but to hawks and other birds of prey. Nature has made harmless and esculent animals fruitful. She has forbid the bird kind to fall short of the number of eggs allotted to each species: and therefore, if the eggs which they intend to fit upon be taken away a certain number of times, they presently lay others in their room; as may be seen in the swallow, duck, and small birds.

## II. PRESERVATION.

1. Preservation follows generation; this appears chiefly in the tender age, while the young are unable to provide for their own support. For then the parents, though otherwise ever so fierce in their disposition, are affected with a wonderful tenderness or sense of love towards their progeny, and spare no pains to provide for, guard, and preserve them; and that not by an imaginary law, but one given by the Lord of nature himself.

Quadrupeds give suck to their tender young, and support them by a liquor perfectly easy of digestion, till their stomachs are able to digest, and their teeth are fit to chew, more solid food. Nay, their love toward them is so great, that they endeavour to repel with the utmost force every thing which threatens danger or destruction to them. The ewe, which brings forth two lambs at a time, will not admit one to her teats unless the other be present and suck also; lest one should famish, while the other grows fat.

Birds build their nests in the most artificial manner, and line them as soft as possible, for fear the eggs should get any damage. Nor do they build promiscuously in any place, but there only where they may quietly lie concealed and be safe from the attacks of their enemies.

The hanging-bird makes its nest of the fibres of withered plants, and the down of the poplar seeds, and fixes it upon the bough of some tree hanging over the water, that it may be out of reach.

The diver places its swimming nest upon the water itself, amongst the rushes. We designedly pass over many instances of the like kind.

Again,

Again, birds sit on their eggs with so much patience, that many of them choose to perish with hunger, rather than expose the eggs to danger by going to seek for food.

The male rooks and crows, at the time of incubation, bring food to the females.

Pigeons, small birds, and other birds which pair, fit by turns; but where polygamy prevails, the males scarcely take any care of the young.

Molt of the duck kind pluck off their feathers in great quantity, and cover their eggs with them, lest they should be damaged by the cold when they quit their nests for the sake of food; and when the young are hatched, who knows not how solicitous they are in providing for them till they are able to fly and shift for themselves?

Young pigeons would not be able to make use of hard feeds for nourishment, unless the parents were to prepare them in their crops, and thence feed them.

The owl called the *eagle-owl* makes its nest on the highest precipices of mountains, and in the warmest spot, facing the sun; that the dead bodies brought there may by the heat melt into a soft pulp, and become fit nourishment for the young.

As an exception indeed to this fostering care of animals, may be mentioned the cuckoo, which lays its eggs in the nest of other small birds, generally the wag-tail, yellow-hammer, or white-throat, and leaves the incubation or preservation of the young to them. This custom of the cuckoo is so extraordinary, and out of the common course of nature, that it would not be credible were it not for the testimony of the most knowing and curious natural-historians, such as Ray, Willoughby, Gesner, Aldrovandus, Aristotle, &c. But this seeming want of instinct is accounted for from the structure and situation of its stomach, which disqualifies it for incubation †; and its instinctive care is still conspicuous in providing a proper, though a foreign, nidus for its eggs.

Amphibious animals, fishes, and insects, which cannot come under the care of their parents, yet owe this to them, that they are put in places where they easily find nourishment.

2. As soon as animals come to maturity, and want no longer the care of their parents, they attend with the utmost labour and industry, according to the law and economy appointed for every species, to the preservation of their lives. But that so great a number of them, which occur every-where, may be supported, and a certain and fixed order may be kept up amongst them, behold the wonderful disposition of the Creator, in assigning to each species certain kinds of food, and in putting limits to their appetites. So that some live on particular species of plants, which particular regions and soils only produce: some on particular animalcula; others on carcases; and some even on mud and dung. For this reason, Providence has ordained that some should swim in certain regions of the watery element; others should fly: some should inhabit the torrid, the frigid, or the temperate zones; and others should frequent deserts, mountains, woods, pools, or meadows, according as the food proper to their nature is found in sufficient quantity. By this means there is no terrestrial tract, no sea, no river, no country, but

what contains and nourishes various kinds of animals. Hence also an animal of one kind cannot rob those of another kind of its aliment; which, if it happened, would endanger their lives or health: and thus the world at all times affords nourishment to so many and so large inhabitants, at the same time that nothing which it produces is useless or superfluous.

It will not be here amiss to produce some instances by which it will appear how providentially the Creator has furnished every animal with such clothing as is proper for the country where they live, and also how excellently the structure of their bodies is adapted to their particular way of life; so that they seem to be destined solely to the places where they are found.

Monkeys, elephants, and rhinoceroses, feed upon vegetables that grow in hot countries, and therefore therein they have their allotted places. When the sun darts forth its most fervid rays, these animals are of such a nature and disposition, that it does them no manner of hurt; nay, with the rest of the inhabitants of those parts, they go naked; whereas, were they covered with hairy skins, they must perish with heat.

On the contrary, the place of rein-deer is fixed in the coldest part of Lapland, because their chief food is the liverwort, which grows no-where so abundantly as there; and where, as the cold is most intense, the rein-deer are clothed, like the most northern animals, with skins filled with the densest hair, by the help of which they easily defy the keenness of the winter. In like manner the rough-legged partridge passes its life in the very Lapland Alps, feeding upon the feeds of the dwarf birch; and, that they may run up and down safely amidst the snow, their feet are feathered.

The camel frequents the sandy and burning deserts, in order to get the barren camel's-hay. How wisely has the Creator contrived for him! he is obliged to go through the deserts, where oftentimes no water is found for many miles about. All other animals would perish with thirst in such a journey: but the camel can undergo it without suffering; for his belly is full of cells, where he reserves water for many days. It is reported by travellers, that the Arabians, when in travelling they want water, are forced to kill their camels, and take water out of their bellies that is perfectly good to drink, and not at all corrupted.

The pelican likewise lives in desert and dry places; and is obliged to build her nest far from the sea, in order to procure a greater share of heat to her eggs. She is therefore forced to bring water from afar for herself and her young; for which reason Providence has furnished her with an instrument most adapted to this purpose: She has a very large bag under her throat, which she fills with a quantity of water sufficient for many days; and this she pours into the nest, to refresh her young, and teach them to swim.

The wild beasts, lions, and tigers, come to this nest to quench their thirst, but do no hurt to the young.

Oxen delight in low grounds, because there the food most palatable to them grows.

Sheep

† See the article *Cuckoo*.

Animal Kingdom.

Animal Kingdom.

Sheep prefer naked hills, where they find a particular kind of grass called the *festuca*, which they love above all things.

Goats climb up the precipices of mountains, that they may browse on the tender shrubs; and in order to fit them for it, they have feet made for jumping.

Horses chiefly resort to woods, and feed upon leafy plants.

Nay, so various is the appetite of animals, that there is scarcely any plant which is not chosen by some, and left untouched by others. The horse gives up the water-hemlock to the goat. The cow gives up the long-leaved water-hemlock to the sheep. The goat gives up the monks-hood to the horse, &c.; for that which certain animals grow fat upon, others abhor as poison. Hence no plant is absolutely poisonous, but only respectively. Thus the spurge, that is noxious to man, is a most wholesome nourishment to the caterpillar. That animals may not destroy themselves for want of knowing this law, each of them is guarded by such a delicacy of taste and smell, that they can easily distinguish what is pernicious from what is wholesome; and when it happens that different animals live upon the same plants, still one kind always leaves something for the other, as the mouths of all are not equally adapted to lay hold of the grass; by which means there is sufficient food for all. To this may be referred an oeconomic experiment well known to the Dutch, that when eight cows have been in a pasture, and can no longer get nourishment, two horses will do very well there for some days; and when nothing is left for the horses, four sheep will live upon it.

Swine get provision by turning up the earth; for there they find the succulent roots, which to them are very delicious.

The leaves and fruits of trees are intended as food for some animals, as the sloth, the squirrel; and these last have feet given them fit for climbing.

Besides myriads of fishes, the caïst, the sea-calf, and others, inhabit the water, that they may there be fed; and their hinder-feet are fit for swimming, and perfectly adapted to their manner of life.

The whole order of the goose-kind, as ducks, merganser, &c. pass their lives in water, as feeding upon water-insects, fishes, and their eggs. Who does not see, that attends ever so little, how exactly the wonderful formation of their beaks, their necks, their feet, and their feathers, suits their kind of life; which observation ought to be extended to all other birds.

The way of living of the sea-swallow deserves to be particularly taken notice of; for as he cannot so commodiously plunge into the water, and catch fish, as other aquatic birds, the Creator has appointed the sea-gull to be his caterer in the following manner. When this last is pursued by the former, he is forced to throw up part of his prey, which the other catches; but in the autumn, when the fishes hide themselves in deep places, the merganser supplies the gull with food, as being able to plunge deeper into the sea. The chief granary of small birds is the knot-grass, that bears heavy seeds, like those of the black bindweed. It is a very common plant, not easily destroyed, either by the road side by trampling upon it, or anywhere else; and is extremely plentiful after

harvest in fields, to which it gives a reddish hue by its numerous seeds. These fall upon the ground, and are gathered all the year round by the small birds. To which we may add, that many small birds feed upon the seeds of plantain, particularly linnets. It is generally known that the goldfinch lives upon the seed of thistles, from which he has its name in Latin and French. Thus bountiful nature feeds the fowls of the air.

The Creator has taken no less care of some amphibious animals, as the snake and frog kind; which, as they have neither wings to fly, nor feet to run swiftly and commodiously, would scarcely have any means of taken their prey, were it not that some animals run, as it were of their own accord, into their mouths. When the rattle-snake, a native of America, with open jaws fixes his eyes on a bird, fly, or squirrel, sitting on a tree, they fly down his throat, being rendered stupid, and giving themselves up as destitute of all refuge. How dreadful this serpent is to other animals will appear by an account we have in a treatise entitled, *Radix Senega*. Where the author (*Ann. Academ. tom. 2*) says, one of these terrible serpents got clandestinely into the house of governor Blake at Carolina; where it would have long lain concealed, had it not been that all the domestic animals, as dogs, hogs, turkeys and fowls, admonished the family by their unusual cries, equally shewing their horror and consternation, their hair, bristles, and crests, standing up an end. On the other hand, we cannot but adore the Creator's great goodness towards man, when we consider the rattle which terminates this serpent's tail: for by means of that we have an opportunity of guarding against this dreadful enemy; the sound warning us to fly; which if we were not to do, and we should be wounded by him, the whole body would be turned into a putrid corruption in six hours, nay sometimes in half an hour.

The limits of this article will not permit us to produce more examples of this kind. But whoever will be at the pains to take ever so slight a view of the wonderful works of the Author of nature, will readily see how wisely the plan, order, and fitness of things with divine ends, are disposed.

3. We cannot without the utmost admiration behold how providently the Creator has acted as to the preservation of those animals which, at a certain time of the year, are by the rigour of the season excluded from the necessaries of life. Thus the bear in the autumn creeps into the moss which he has gathered, and there lies all winter; subsisting upon no other nourishment but his fat, collected during the summer in the cellular membrane, and which without doubt, during his fast, circulates through his vessels, and supplies the place of food; to which perhaps is added that fat juice which he sucks out of the bottom of his feet.

The hedge-hog, badger, and mole, in the same manner fill their winter-quarters with vegetables, and sleep during the frosts. The bat seems cold and quite dead all the winter. Most of the amphibious animals get into dens, or to the bottom of lakes and pools.

In the autumn, as the cold approaches, and insects disappear, swallows migrate into other climes in search of food and a temperature of air more friendly to their

their constitution: though the later hatches, or those young birds which are incapable of distant flights, seek for an asylum against the violence of the cold in the bottom of lakes amongst the reeds and rushes; from whence, by the wonderful appointment of nature, they come forth again. See the article *HIBRIDO*. The peristaltic motion of the bowels ceases in all these animals while they are obliged to fast; whence the appetite is diminished, and so they suffer the less from hunger. To this head may be referred the observation of the celebrated Lister concerning those animals, That their blood, when let into a basin, does not coagulate, as that of all other animals; and so is no less fit for circulation than before.

The moor-fowls work themselves out-walks under the very snow. They moult in the summer; so that about the month of August they cannot fly, and are therefore obliged to run into the woods; but then the moor-berries and bilberries are ripe, from whence they are abundantly supplied with food. Whereas the young do not moult the first summer; and therefore, though they cannot run so well, are able to escape danger by flight.

The rest of the birds who feed upon insects migrate every year to foreign regions, in order to seek for food in a milder climate; while all the northern parts, where they live well in the summer, are covered with snow.

By these migrations, birds also become useful to many different countries, and are distributed over almost all the globe. And it must excite our admiration that all of them exactly observe the times of coming and going, and that they do not mistake their way.

Insects in the winter generally lie hid within their cases, and are nourished by the surrounding liquor like the fetus of other animals; from whence, at the approach of spring, they awake, and fly forth, to the amusement of every one.

However, all animals which lie hid in winter do not observe these laws of fasting. Some provide store-houses in summer and autumn, from which they take what is necessary; as mice, jays, squirrels, bees.

### III. DESTRUCTION.

1. We have observed above, that all animals do not live upon vegetables, but that there are some which feed upon certain animalcula. Nay, there are some which subsist only by rapine, and daily destroy numbers of the peaceable kind.

These animals are destroyed, but in such a manner that the weaker generally are infested by the stronger in a continued series. Thus the tree-louse lives upon plants. The fly called *musca aphidivora* lives upon the tree-louse; the hornet and wasp-fly, upon the *musca aphidivora*; the dragon-fly, upon the hornet and wasp fly; the spider, on the dragon-fly; the small birds on the spider; and lastly, the hawk kind on the small birds.

In like manner, the monoculus delights in putrid waters, the knat eats the monoculus, the frog eats the knat, the pike eats the frog, the sea-calf eats the pike.

The bat and goat-sucker make their excursions only at night, that they may catch the moths, which at that time fly about in vast quantities.

The woodpecker pulls out the insects which lie hid in the trunks of trees.

The swallow pursues those which fly about in the open air.

The mole pursues worms. The large fishes devour the small. Nay, we scarcely know an animal which has not some enemy to contend with.

Amongst quadrupeds wild beasts are most remarkably pernicious and dangerous to others, as the hawk kind among birds. But that they may not, by too atrocious a butchery, destroy whole species, even these are circumscribed within certain bounds. First, as to the most fierce of all, it deserves to be noted how few they are in proportion to other animals. Secondly, the number of them is not equal in all countries. Thus France and England breed no wolves, and the northern countries no tigers or lions. Thirdly, these fierce animals sometimes fall upon and destroy one another. Thus the wolf devours the fox. The dog infests both the wolf and fox; nay, wolves in a body will sometimes venture to surround a bear. The tiger often kills its own male fellows. Dogs are sometimes seized with madness, and destroy their fellows, or with the mangle destroy themselves.

Lastly, wild beasts seldom arrive at so great an age as animals which live on vegetables. For they are subject, from their alkaline diet, to various diseases, which bring them sooner to an end.

But although all animals are infested by their peculiar enemies, yet they are often able to elude their violence by stratagems and force. Thus the hare often confounds the dog by her windings.

When the bear attacks sheep and cattle, these draw up together for mutual defence. Horses join heads together, and fight with their heels. Oxen join tails, and fight with their horns.

Swine get together in herds, and boldly oppose themselves to any attack, so that they are not easily overcome; and it is worth while to observe, that all of them place their young, as less able to defend themselves, in the middle, that they may remain safe during the battle.

Birds, by their different ways of flying, oftentimes escape the hawk. If the pigeon had the same way of flying as the hawk, she would hardly ever escape his claws.

It deserves also to be remarked, how much some animals consult their safety by night. When horses sleep in woods, one by turn remains awake, and, as it were, keeps watch. When monkeys in Brazil sleep upon trees, one of them keeps awake, in order to give the sign when the tiger creeps towards them; and in case the guard should be caught asleep, the rest tear him to pieces. Hence the hunting of rapacious animals is not always successful, and they are often obliged to labour for a whole day to no purpose. For this reason the Creator has given them such a nature, that they can bear fasting a long time. Thus the lion lurks in his den many days without famishing; and the wolf, when he has once well satisfied his hunger, can fast many weeks without any difficulty.

If we consider the end for which it pleased the Supreme Being to constitute such an order of nature, that some animals should be, as it were, created only to be miserably butchered by others, it seems that his

Animal Kingdom.

Providence not only aimed at sustaining, but also keeping a just proportion amongst all the species; and so prevent any one of them from increasing too much, to the detriment of men and other animals. For if it be true, as it is most assuredly, that the surface of the earth can support only a certain number of inhabitants, they must all perish if the same number were doubled or tripled.

There are some viviparous flies which bring forth 2000 young. These in a little time would fill the air, and like clouds intercept the rays of the sun, unless they were devoured by birds, spiders, and many other animals.

Storks and falcons free Egypt from frogs, which, after the inundation of the Nile, cover all the country. The same birds also clear Palestine of mice. Bellonius on this subject says as follows: "The storks come to Egypt in such abundance, that the fields and meadows are white with them. Yet the Egyptians are not displeas'd with this sight; as frogs are generated in such numbers there, that did not the storks devour them, they would over-run every thing. Besides, they also catch and eat serpents. Between Belba and Gaza, the fields of Palestine are often desert on account of the abundance of mice and rats; and were they not destroyed by the falcons, that come here by instinct, the inhabitants could have no harvest."

The white fox is of equal advantage in the Lapland Alps; as he destroys the Norway rats, which are generated there in great abundance, and thus hinders them from increasing too much in proportion, which would be the destruction of vegetables.

It is sufficient for us, that nothing is made by Providence in vain; and that whatever is made, is made with supreme wisdom. For it does not become us to pry too boldly into all the designs of God. Let us not imagine, when these rapacious animals sometimes do us mischief, that the Creator planned the order of nature according to our private principles of oeconomy: for the Laplanders have one way of living; the European husbandman another; the Hottentots and savages a third; whereas the stupendous oeconomy of the Deity is one throughout the globe; and if Providence does not always calculate exactly according to our way of reckoning, we ought to consider this affair in the same light, as when different seamen wait for a fair wind, every one with respect to the part he is bound to, who we plainly see cannot all be satisfied.

2. The whole earth would be overwhelmed with carcases and stinking bodies, if some animals did not delight to feed upon them. Therefore, when an animal dies, bears, wolves, foxes, ravens, &c. do not lose a moment till they have taken all away. But if a horse, *e. g.* dies near the public road, you will find him, after a few days, swollen, burst, and at last filled with innumerable grubs of carnivorous flies, by which he is entirely consumed, and removed out of the way, that he may not become a nuisance to passengers by his poisonous stench.

When the carcases of fishes are driven upon the shore, the voracious kinds, such as the thornback, the hound-fish, the conger-eel, &c. gather about and eat them. But because the flux and reflux soon change

the state of the sea, they themselves are often detained in pits, and become a prey to the wild beasts that frequent the shores. Thus the earth is not only kept clean from the putrefaction of carcases, but at the same time, by the oeconomy of nature, the necessaries of life are provided for many animals. In the like manner many insects at once promote their own good, and that of other animals. Thus gnats lay their eggs in stagnant, putrid, and stinking waters, and the grubs that arise from these eggs clear away all the putrefaction: and this will easily appear, if any one will make the experiment by filling two vessels with putrid water, leaving the grubs in one, and taking them all out of the other; for then he will soon find the water that is full of grubs pure and without any stench, while the water that has no grubs will continue stinking.

Lice increase in a wonderful manner in the heads of children that are scabby; nor are they without their use, for they consume the redundant humours.

The beetle kind in summer extract all moist and glutinous matter out of the dung of cattle, so that it becomes like dust, and is spread by the wind over the ground. Were it not for this, the vegetables that lie under the dung would be so far from thriving, that all that spot would be rendered barren.

As the excrements of dogs is of so filthy and septic a nature that no insect will touch them, and therefore they cannot be dispersed by that means, care is taken that these animals should exonerate upon stones, trunks of trees, or some high place, that vegetables may not be hurt by them.

Cats bury their dung. Nothing is so mean, nothing so little, in which the wonderful order and wise disposition of nature do not shine forth.

Lastly, all these treasures of nature, so artfully contrived, so wonderfully propagated, so providentially supported throughout her three kingdoms, seem intended by the Creator for the sake of man. Every thing may be made subservient to his use, if not immediately, yet mediately; not so to that of other animals. By the help of reason man tames the fiercest animals; pursues and catches the swiftest; nay, he is able to reach even those which lie hid in the bottom of sea.

By the help of reason, he increases the number of vegetables immensely; and does that by art, which nature, left to herself, could scarcely effect. By ingenuity he obtains from vegetables whatever is convenient or necessary for food, drink, cloathing, medicine, navigation, and a thousand other purposes.

He has found the means of going down into the abyss of the earth, and almost searching its very bowels. With what artifice has he learned to get fragments from the most rocky mountains, to make the hardest stones fluid like water, to separate the useful metal from the useless dross, and to turn the finest sand to some use! In short, when we follow the series of created things, and consider how providentially one is made for the sake of another, the matter comes to this, that all things are made for the sake of man; and for this end more especially, that he, by admiring the works of the Creator, should extol his glory, and at once enjoy all those things of which he stands in need, in order to pass his life conveniently and pleasantly.

## CONCLUSION.

THIS subject concerning the works of nature, a very small part of which we have been able to touch upon, is of such importance and dignity, that if it were to be properly treated in all its parts, men would find wherewithal to employ almost all the powers of the mind. Nay, time itself would fail before even the most acute human sagacity would be able to discover the amazing economy, laws, and exquisite structure, of the least insect; since, as Pliny observes, nature nowhere appears more herself than in her most minute works.

Summary as it is, however, the preceding view, as it were in a map, of the several parts of nature, their connections and dependencies, may, among other uses, convey an useful lesson, and such an one as the best of us often need to have inculcated.

From a partial consideration of things, we are very apt to criticise what we ought to admire; to look upon as usefess what perhaps we should own to be of infinite advantage to us, did we see a little farther; to be peevish where we ought to give thanks; and at the same time to ridicule those who employ their time and thoughts in examining what we were (i. e. some of us most assuredly were) created and appointed to study. In short, we are too apt to treat the Almighty worse than a rational man would treat a good mechanic, whose works he would either thoroughly examine, or be ashamed to find any fault with them. This is the effect of a partial consideration of nature; but he who has the candour of mind and leisure to look farther, will be inclined to cry out,

How wond'rous is this scene! where all is form'd  
With number, weight, and measure! all design'd

## N A T

NATURAL *Philosophy*, that which considers the powers and properties of natural bodies, and their mutual actions one on another. See *PHYSICS*.

The business of natural philosophy, says Boerhaave, is to communicate a solid and accurate knowledge of all the bodies in being, and all the affections thereof. Nor can this science be acquired otherwise than by observing, by means of our senses, all the objects which the Author of nature hath made cognizable thereto: hence, the first and principal part of this science is to collect all the manifest and sensible appearances of things, and reduce them into a body of natural history. Now there are two ways of making such observations; the first, when we view things nearly as they happen to turn up, without any design or intervention of our own: in which way no great improvements can be expected in the art, because chance, having here the direction, only exhibits occasional or extemporary properties. The other method is, when, after a thorough acquaintance with bodies, we apply them to other bodies equally known, diligently attending to the result, and observing whether any thing new arises. See *EXPERIMENTAL PHILOSOPHY*.

*NATURALIZATION*, in law, the act of naturalizing an alien, or putting him into the condition of a natural-born subject, and entitling him to the

For some great end! where not alone the plant  
Of stately growth; the herb of glorious hue,  
Or food-full substance; nor the labouring steed;  
The herd, and flock, that feed us; nor the mine  
That yields us flues for elegance, and use;  
The fen that loads our table, and covers  
The wanderer man from climate to climate; with all  
Those rolling spheres, that from on high shed down  
Their kindly influence: nor these alone,  
Which strike ev'n eyes incurious; but each mof,  
Each shell, each crawling insect, holds a rank  
Important in the plan of Him who fram'd  
This scale of beings; holds a rank, which lost  
Would break the chain, and leave behind a gap  
Which nature's self would rue. Almighty Being,  
Cause and support of all things, can I view  
These objects of my wonder, can I feel  
These fine sensations, and not think of thee?  
Thou who dost thro' th' eternal round of time,  
Dost thro' th' immensity of space exist  
Alone, shalt thou alone excluded be  
From this thy universe? Shall feeble man  
Think it beneath his proud philosophy  
To call for thy assistance, and pretend  
To frame a world, who cannot frame a clod?—  
Not to know thee, is not to know ourselves—  
Is to know nothing—nothing worth the care  
Of man's exalted spirit—all becomes,  
Without thy ray divine, one dreary gloom,  
Where lurk the monsters of fantastic brains,  
Order bereft of thought, uncaus'd effects,  
Fate freely acting, and unerring Chance.  
Where meanless matter to a chaos sinks,  
Or something lower still; for without thee  
It crumbles into atoms void of force,  
Void of resistance—it eludes our thought.  
Where laws eternal to the varying code  
Of self-love dwindle. Interest, passion, whim,  
Take place of right and wrong; the golden chain  
Of beings melts away, and the mind's eye  
Sees nothing but the present. All beyond  
Is visionary guess—is dream—is death.

THOMSON.

## N A T

rights and privileges thereof. See *ALIEN*, and *DE-NATURALIZATION*.

In France, naturalization is the king's prerogative; in England, it is only done by act of parliament.

In France, Swifs, Savoyards, and Scots, need not any naturalization, being reputed regnicoles, or natives.

*NATURALS*, among physicians, whatever naturally belongs to an animal, in opposition to non-naturals. See *NON-NATURALS*.

*NATURE*, according to Mr Boyle, has eight different significations; it being used, 1. For the Author of nature, whom the schoolmen call *Natura Naturans*, being the same with God. 2. By the nature of a thing, we sometimes mean its essence; that is, the attributes which make it what it is, whether the thing be corporeal or not; as when we attempt to define the nature of a fluid, of a triangle, &c. 3. Sometimes we confound that which a man has by nature, with what accrues to him by birth; as when we say, that such a man is noble by nature. 4. Sometimes we take nature for an internal principle of motion; as when we say, that a stone by nature falls to the earth. 5. Sometimes we understand, by nature, the established course of things. 6. Sometimes we take nature for an aggregat of powers belonging to a body,

Naturals.  
Nature.

Nature,  
Naval.

body, especially a living one; in which sense physicians say, that nature is strong, weak, or spent; or that, in such or such diseases, nature left to herself will perform the cure. 7. Sometimes we use the term *nature* for the universe, or whole system of the corporeal works of God; as when it is said of a phoenix, or chimera, that there is no such thing in nature. 8. Sometimes too, and that most commonly, we express by the word *nature* a kind of semi-deity, or other strange kind of being.

If, says the same philosopher, I were to propose a notion of nature, less ambiguous than those already mentioned, and with regard to which many axioms relating to that word may be conveniently understood, I should first distinguish between the universal and the particular nature of things. Universal nature I would define to be the aggregate of the bodies that make up the world in its present state, considered as a principle; by virtue whereof they act and suffer, according to the laws of motion prescribed by the Author of all things. And this makes way for the other subordinate notion; since the particular nature of an individual consists in the general nature applied to a distinct portion of the universe; or, which is the same thing, it is a particular assemblage of the mechanical properties of matter, as figure, motion, &c.

*Kingdoms of NATURE.* See KINGDOMS.

*Conduct or Operations of NATURE.* See NATURAL History.

**NAVAL**, something relating to a ship; and hence, *Naval Architecture.* See SHIP-Building.

**Naval Camp**, in antiquity, a fortification, consisting of a ditch and parapet on the land-side, or a wall built in the form of a semi-circle, and extended from one point of the sea to another. This was sometimes defended with towers, and beautified with gates, through which they issued forth to attack their enemies. Homer hath left us a remarkable description of the Grecian fortifications of this sort, in the Trojan war, beginning at v. 436. *Iliad* v.

Then, to secure the camp and naval powers,  
They rais'd embattled walls with lofty tow'rs:  
From space to space were ample gates around,  
For passing chariots; and a trench profound,

Of large extent; and deep in earth below  
Strong piles infix'd flood adverse to the foe.

POPE'S *Transf.*

Towards the sea, or within it, they fixed great pales of wood, like those in their artificial harbours; before these of burden were placed in such order, as that they might be instead of a wall, and give protection to those within; in which manner Nicias is reported by Thucydides to have encamped himself: but this seems only to have been practised when the enemy was thought superior in strength, and raised great apprehensions of danger in them. When their fortifications were thought strong enough to defend them from the assaults of enemies, it was frequent to drag their ships to shore, which the Greeks called *εναξαις*, the Romans *subducere*. Around the ships the soldiers disposed their tents, as appears every where in Homer: but this seems only to have been practised in winter, when their enemy's fleet was laid up and could not assault them; or in long sieges, and when they lay in no danger from their enemies by sea; as in the Trojan war, where the defenders of Troy never once attempted to encounter the Grecians in a sea-fight.

The adjacent places were usually filled with ins and stews, well stocked with females, that prostituted themselves to the mariners, merchants, and artificers of all sorts, who stocked thither in great numbers; this, however, appears to be only in times of peace.

**Naval Crown**, among the ancient Romans, a crown adorned with figures of prows of ships, conferred on persons who in sea-engagements first boarded the enemy's vessel. See CROWN.

**Naval Engagement.** See NAVAL Tactics, chap. vii.

**Naval Stores**, comprehend all those particulars made use of, not only in the royal navy, but in every other kind of navigation; as timber and iron for shipping, pitch, tar, hemp, cordage, sail-cloth, gunpowder, ordnance, and fire-arms of every fort, ship-chandlery wares, &c.

## NAVAL TACTICS;

### Or, The Military Operations of Fleets.

**NAVAL TACTICS** is the art of ranging fleets in such order or disposition, as may be judged most convenient, either for attacking, defending, or retreating to the greatest advantage; and to regulate their several movements accordingly: it is not a science established on principles absolutely invariable, but founded on such reasons as the alteration, and improvement of arms must necessarily occasion in a course of time and experience; from which also will naturally result a difference in the construction of ships, in the manner of working them, and, in fine, in the total disposition and regulation of fleets and squadrons. We shall cursorily run through this succession and change of arms, &c. to the present improvement of our lines of battle, in order to make us the more sensible of the reasons

which have induced the moderns to prefer so advantageous a choice as they now follow in the arrangement of their ships.

The ancient galleys were so constructed as to carry several banks of oars, very differently disposed from those in our modern galleys, which, however, vary the least of any others from their ancient model. Advanced by the force of their oars, the galleys ran violently aboard of each other, and by the mutual encounter of their beaks and prows, and sometimes of their sterns, endeavoured to dash in pieces or sink their enemies.

The prow, for this purpose, was commonly armed with a brazen point or trident, nearly as low as the surface of the sea, in order to pierce the enemy's ships under the water. Some of the galleys were furnished

with large turrets, and other accensions of building, either for attack or defence. The soldiers also annoyed their enemies with darts and slings, and, on their nearer approach, with swords and javelins; and in order that their missile weapons might be directed with greater force and certainty, the ships were equipped with several platforms, or elevations above the level of the deck. The sides of the ship were fortified with a thick fence of hides, which served to repel the darts of their adversaries, and to cover their own soldiers, who thereby annoyed the enemy with greater security.

As the invention of gun-powder has rendered useless many of the machines employed in the naval wars of the ancients, the great distance of time has also consigned many of them to oblivion: some few are, nevertheless, recorded in ancient authors, of which we shall endeavour to present a short description. And first,

The *Δολφιν* was a large and massy piece of lead or iron, cast in the form of a dolphin. This machine being suspended by blocks at their mast-heads or yard-arms, ready for a proper occasion, was let down violently from thence into the adverse ships; and either penetrated through their bottom, and opened a passage for the entering waters, or by its weight immediately sunk the vessel.

The *Δρεπανον* was an engine of iron crooked like a sickle, and fixed on the top of a long pole. It was employed to cut asunder the slings of the sail-yards, and, thereby letting the sails fall down, to disable the vessel from escaping, and incommode her greatly during the action. Similar to this was another instrument, armed at the head with a broad two-edged blade of iron, wherewith they usually cut away the ropes that fastened the rudder to the vessel.

*Δορῆα γαυμαχικα*, a sort of spears or maces of an extraordinary length, sometimes exceeding 20 cubits, as appears by the 15th Iliad of Homer, by whom they are also called *μακροα*.

*Κεκραται* were certain machines used to throw large stones into the enemy's ships.

Vegetius mentions another engine, which was suspended to the main-mast, and resembled a battering-ram; for it consisted of a long beam and an head of iron, and was with great violence pushed against the sides of the enemy's galleys.

They had also a grappling-iron, which was usually thrown into the adverse ship by means of an engine: this instrument facilitated the entrance of the soldiers appointed to board, which was done by means of wooden bridges, that were generally kept ready for this purpose in the fore-part of the vessel. See the article *CORVUS*.

The arms used by the ancients rendered the disposition of their fleets very different, according to the time, place, and circumstances. They generally considered it an advantage to be to windward, and to have the sun shining directly on the front of their enemy. The order of battle chiefly depended on their power of managing the ships, or of drawing them readily into form; and on the schemes which their officers had concerted. The fleet being composed of rowing-vessels, they lowered their sails previous to the action; they presented their prows to the enemy, and advanced against each other by the force of their oars. Before they joined

battle, the admirals went from ship to ship, and exhorted their soldiers to behave gallantly. All things being in readiness, the signal was displayed by hanging out of the admiral's galley a gilded shield, or a red garment or banner. During the elevation of this, the action continued; and by its depression, or inclination towards the right or left, the rest of the ships were directed how to attack or retreat from their enemies. To this was added the found of trumpets; which began in the admiral's galley, and continued round the whole navy. The fight was also begun by the admiral's galley, by grappling, boarding, and endeavouring to overset, sink, or destroy the adversary, as we have above described. Sometimes, for want of grappling-irons, they fixed their oars in such a manner as to hinder the enemy from retreating. If they could not manage their oars as dextrously as their antagonist, or fall alongside so as to board him, they penetrated his vessel with the brazen prow. The vessels approached each other as well as their circumstances would permit, and the soldiers were obliged to fight hand to hand, till the battle was decided: nor indeed could they fight otherwise with any certainty, since the shortest distance rendered their slings and arrows, and almost all their offensive weapons, ineffectual, if not useless.

The squadrons were sometimes ranged in two or three right lines, parallel to each other; being seldom drawn up in one line, unless when formed into an half-moon. This order indeed appears to be the most convenient for rowing vessels that engage by advancing with their prows towards the enemy. At the battle of Ecnomus, between the Romans and the Carthaginians, the fleet of the former was ranged into a triangle, or a sort of wedge in front, and towards the middle of its depth, of two right parallel lines. That of the latter was formed into a rectangle, or two sides of a square, of which one branch extended behind, and as the opening of the other prosecuted the attack, was ready to fall upon the flank of such of the Roman galleys as should attempt to break their line. Ancient history has preserved many of these orders, of which some have been followed in later times. Thus, in a battle A. D. 1340, the English fleet was formed in two lines, the first of which contained the larger ships, the second consisted of all the smaller vessels, used as a reserve to support the former whenever necessary. In 1545, the French fleet under the command of the *Marschal d'Annebault*, in an engagement with the English in the Channel, was arranged in the form of a crescent. The whole of it was divided into three bodies, the centre being composed of 36 ships, and each of the wings of 30. He had also many galleys; but these fell not into the line, being designed to attack the enemy occasionally. This last disposition was continued down to the reigns of James I. and Lewis XIII.

Meanwhile the invention of gunpowder, in 1330, gradually introduced the use of fire-arms into naval war, without finally superseding the ancient method of engagement. The Spaniards were armed with cannon in a sea-fight against the English and the people of Poitou abreast of Rochelle in 1372; and this battle is the first wherein mention is made of artillery in our navies. Many years elapsed before the marine armaments were sufficiently provided with fire-arms. So great a revolution in the manner of fighting, and which



Of Lines or Orders. necessarily introduced a total change in the construction of ships, could not be suddenly effected. In short, the squadrons of men of war are no longer formed of rowing vessels, or composed of galleys and ships of the line; but entirely of the latter, which engage under sail, and discharge the whole force of their artillery from their sides. Accordingly, they are now disposed in no other form than that of a right line parallel to the enemy; every ship keeping close-hauled upon a wind on the same tack. Indeed, the difference between the force and manner of fighting of ships and galleys rendered their service in the same line incompatible. When we consider therefore the change introduced, both in the construction and working of ships, occasioned by the use of cannon, it necessarily follows, that squadrons of men of war must appear in the order that is now generally adopted.

The machines which owe their rise to the invention of gun-powder have now totally supplanted the others; so that there is scarce any but the sword remaining, of all the weapons used by the ancients. Our naval battles are therefore almost always decided by fire-arms, of which there are several kinds, known by the general name of *artillery*.

In a ship of war, fire-arms are distinguished into cannon mounted on carriages, swivel-cannon, grenades, and musquetry. See *CANNON*, &c.

Besides these machines, there are several other used in merchant-ships and privateers, as coehorns, carabines, fire-arrows, organs, stink-pots, &c. See *COEHORN*, &c.

CHAP. I. *Of Lines or Orders.*

By orders are meant the different methods of ranging or drawing up a fleet in the several lines and forms for which it may be designed: in which two things are to be considered, 1. The position of each ship with regard to the wind: 2. The position of each ship with respect to the fleet. We cannot make any alteration in either of these circumstances, without changing the whole position of the line, which will otherwise remain complete.

The different expeditions an admiral may be ordered upon, as well as the various circumstances that occur in conducting a fleet, first gave rise to the several lines or orders into which it is formed.

When a fleet engages, it ought to be drawn up in a different form from that in which it sails. A fleet that sails in sight of an enemy must alter its position, from that which it would maintain were there none in view, or none to be expected. When a fleet sails before the wind, it has likewise its particular form of sailing; as it has also when it chases the enemy, makes a retreat, guards a freight or passage, or is obliged to force through one; or whether at anchor in a road or harbour, or going into either to insult or attack an enemy. In this variety of circumstances, proper regard must be had to the most advantageous position or form into which the fleet can be ranged before it enters upon action.

CHAP. II. *Of dividing a Fleet, and of the Form of Sailing.*

1. *How to divide a fleet.* When a fleet consists of 60 sail of the line, the admiral divides it first into three

squadrons, each of which has its divisions; and three general officers, viz. admiral, vice-admiral, and rear-admiral. Each squadron has its proper colours, and each division its proper mast: for example, the white flag is proper to the first squadron of France, the white and blue for the second, and the blue for the third. In Britain, the first admiral of the fleet carries the union-flag at the main-top-mast head; next, the admiral of the white; and then the admiral of the blue. The particular ships carry pendants of the same colour with their squadrons, and at the masts of their respective divisions; so that the last ship in the division of the blue squadron wears a blue pendant at the mizen top-mast head.

The general officers, or commanders of divisions, place themselves in the centre of their divisions. We must except the three commanding admirals, who in a sailing position lead their respective squadrons.

2. *The sailing form of a Fleet.* The following is judged the best, and is that which is put in practice upon most occasions, whether upon expeditions, looking out for an enemy, &c. It consists in dividing the fleet into three columns, or parallel lines, either upon a wind or large, as the admiral may think most expedient. Thus will the course and distance of the columns, as well as each ship's station, be determined and regulated; observing at the same time that they keep abreast of each other as near as possible.

By this manner of sailing, the fleet is closed as much as possible, can better observe the proper signals, and is ready to be ranged or formed into any position or line that the admiral shall judge proper. In sailing, care must be taken to preserve the just distance between the columns; in order to which, it will be best for the ships in general to regulate themselves by some of the centre ships of the column to windward, rather than the sternmost, as they are often too far in their rear to follow their motions.

The most natural course in this order of sailing is to go nearest upon a wind on either tack, or to go away large three or four points: however, the fleet may steer away more or less from the wind, or even right abreast it, as may be judged most expedient.

In all forms of sailing, the transports, tenders, &c. are ordered to keep to windward, for the following reasons. 1. They are by such a situation more out of danger from the enemy, as they can the readier bear down into the body of the fleet to avoid them. 2. They can more expeditiously execute the admiral's orders, when necessary. 3. They do not delay the fleet by waiting for them, being siter to make sail before than upon a wind.

This kind of ships ought not to keep farther than half a league, for the same reasons that they are ordered to keep to windward; but we must observe, that when the fleet is not drawn up in a line or three columns, the fire-ships, &c. ought not to be farther distant from the men of war than they are from one another.

The same reasons which prevail in placing the fire-ships, &c. to windward of a fleet in a sailing posture, will equally hold good to place them to leeward when obliged to make a retreat. 1. They are there in less danger from the pursuit of an enemy, because they are

Sur-

*Of Chacing.* furrounded by the fleet to guard them, in the form of a half-moon, from any attack that may be made upon them. 2. The fleet going large in this form, these small ships may shorten sail to wait for orders. 3. If the fleet should be obliged to resume the line of battle again to engage the enemy, they will still be in the best position to fall in.

In the order of retreat, the fore-ships, &c. keep themselves at a greater distance than in any other form, 1. That they may not retard the progress of the fleet. 2. When the fleet forms again into a line of battle, they may keep better the proper distance required.

The fire-ships, &c. of the fleet to leeward ought to keep themselves a little a-head of those ships whose orders they are to follow; to the end that they may be the readier to join them upon occasion.

### CHAP. III. *Of Chacing.*

Plate  
CXCVI.  
fig. 1.

1. *To chase with the greatest advantage.* If the ship that chases is a great way to leeward of the chace, she should continue on the same board, till she can tack upon her: that is to say, arriving at the point E, she will find the chace at the point F; so that the angle FED will make four points, or  $45^{\circ}$ .

The above method is thought to be the best by the most experienced seamen; because by working in this manner you keep nigher the chace, and by making two tacks you will fetch her wake.

2. The ship D may continue on the same tack, till she entirely cuts off the chace C; but then she runs the risk of losing sight of her, by continuing too long upon the same tack: a fog, a shift of wind, a head-land, night coming on, and many other incidents that frequently happen at sea, may give the chace an opportunity of escaping, by altering her course, &c. therefore we should never put this method in practice, but when very near her, or when we chase a friend in order to join him.

Fig. 2.

3. If the ship A chasing the ship B to windward, is at a very great distance, she must continue on the same tack till she gets upon her beam; then the ship A will tack, and stand on again the same with the chace, till she brings the ship B abreast of her. She must continue on in the same manner, tacking every time she gets abreast of the chace, till she is no longer apprehensive of losing sight of her. *Note.* This is to be understood when the ship A is at a very great distance from the chace, because that then she would run too great a length from her, were she to continue on the same tack till she could fetch the ship B: but then again, when the ship A is but at a small distance from the ship B, she would loose too much time if she were to tack always when she got a-breast of the chace.

Fig. 3.

4. We have already observed, that if the ship B is to leeward of the ship A which she chases, and under no apprehension of losing sight of her; or because she might not be at any great distance from her, or chases her large, in proper settled weather, when the days are long; or that she might be a friend, whom you would willingly join: then the ship B ought to continue on the same tack with the ship A, till she can cut her off upon the other tack.

Now we must know how to determine if the ship B in tacking will fetch the ship A. 1. It is evident, that if the ship B, which is supposed to be a better sailer

than the chace A, continues still on the same board till she gets as far to windward as the ship A, she may easily intercept her by tacking upon her: this appears, at first sight, as if we should reject this method, because it makes the ship B continue on one tack longer than is necessary: but still good judges think it should not be entirely rejected, because the ship B may thoroughly make up for her loss of time in continuing on so long a-board; for she may then bear down upon the ship A as much as she thinks proper, at the same time obliging her not to alter her course, as was remarked above. 2. The ship B will exactly know when she ought to tack upon the chace A, if she calculates the time from her being abreast of her till she thinks proper to tack upon her again: for continuing on the same length of time, she may be certain she cannot fail of intercepting her.

5. When the admiral would have the whole fleet to chace, or a particular squadron only, he will make known the same accordingly by hoisting the usual signal for making fail, whether his intention be to chace or join some ships that appear in sight, or stretch out a-head, and make the land. In the first case, the ships should prepare themselves immediately, that no time may be lost in wearing or tacking, if occasion for either. In the second, the headmost ships should bring to, to sound, if the coast is not thoroughly known to the fleet.

6. The squadron that chases, or the cruisers detached from the fleet, should be very careful not to engage too far in the chace, for fear of being overpowered; however, not to omit, at the same time, thoroughly satisfying themselves with regard to the object of their chace, if possible. They must pay great attention to the admiral's signals at all times, to prevent separation; in order to which, they should collect themselves before night, especially if there be any appearance of thick or foggy weather coming on, and endeavour to join the fleet again.

7. If the admiral would have the whole fleet to chace, without observing any particular form, he will, to avoid confusion, prepare them accordingly for it by signal to look out and watch his motions; to which he will join the general signal to chace at large: then the ships are immediately to get ready to make fail, as soon as the admiral shall think proper to signify his orders to chace in any particular quarter, or for any other movement he would have them execute; thus he will be able to inform himself (as the signal might perhaps be for that purpose only) which are the best sailing ships, and which the most experienced and skilful officers in his fleet; all which, with their several methods of working and sailing, will give him an opportunity of knowing them more thoroughly, that he may employ them accordingly, whenever the service should require the exertion of their respective abilities and experience.

When the admiral would have only a particular squadron to chace at pleasure, he will make a preparatory signal for that squadron to look out and watch his motions with its distinguishing flag, and that of chacing at large; but the ships are not to begin the chace before the signal for the execution of the particular motion is hoisted at the mast-head which denotes the said squadron.

of  
Anchoring.

OF  
Anchoring.

The ships are diligently to observe when the admiral makes the signal to give over chace, that is, regarding the admiral's ship as a fixed point, is to work back, or make fail into her station, to form the order or line again, as expeditiously as the nature of the chace and distance will permit.

8. After the ship has signified to the admiral that she expects to come up with the chace, and that, if an enemy, she can attack her to advantage, she must be then very attentive to the admiral's signs in return, whether of approbation or disapprobation, which no doubt he will make upon the occasion, lest she should unwarily engage too far, and against the admiral's orders. On the signal of disapprobation, she must absolutely quit the chace, and return again into the fleet at all events.

9. The same signal that the admiral makes to give over the engagement, will serve at the same time for the ships to rally or return again to their respective stations; the commanders of squadrons will repeat it, that the ships may work properly and with expedition, to form their line as before; each commanding officer with respect to the commander in chief, and the rest of the ships with regard to the chiefs of their divisions or commanders of squadrons.

If the action continue till night, the admiral will make the general signal for rallying, when each commander of a squadron is to make the same for his particular ships.

Sometimes the signal for discontinuing the action might regard only a particular part of the fleet, which will be signified accordingly by the proper distinguishing flag of that body or division.

10. *To avoid the chace.* If the ship that is chased be to windward, she must keep on the tack on which she finds she gains most on the enemy, to keep him at the greatest distance; if to leeward, she will go right before the wind, or more or less large, according as she finds either most to her advantage, and more agreeable to her particular properties in sailing or working.

#### CHAP. IV. *Of Anchoring.*

WHEN a fleet comes to an anchor, there are five circumstances to be considered: 1. That the ground be good and holding. 2. That the place be well sheltered against the reigning winds that blow on the coast where you anchor. 3. That you may easily get under fail with the same wind that may serve an enemy, and at the same time be able to dispute the advantage of the wind with them. 4. That you can readily form the line as soon as you get under fail. 5. That the ships may have room to keep clear of each other in getting under way: in order to which we should give the ships a good birth when we come to anchor, making one or many lines, about three cables length asunder, and 120 fathom between each ship.

EXAMPLE. It was no doubt by such wise precautions that the duke of York saved his fleet in Solebay in the year 1672; it was composed of 60 English and 30 French ships. His royal highness kept the sea a long time to draw out the Dutch to a decisive action: but seeing they still persisted to secure themselves amidst the banks and shoals of their own coast, and could not by any means force them to a battle, he

took the resolution of returning to Solebay, to refresh and recruit his men with proper necessaries. Admiral de Ruyter, who commanded the Dutch fleet, thought proper not to let slip so happy a conjuncture, as he imagined, of surprising the English as they lay at an anchor in the road: he accordingly set sail with all his fleet, which was equal to the duke of York's, on the 6th of June, and stretched over on the English coast, with the wind at N. E. for Solebay, where he did not doubt but he should meet with the enemy in some disorder and confusion. But the duke, like an experienced officer, ordered the count d'Etrées, vice-admiral, and afterwards marshal of France, who commanded the van, to anchor out in the offing; placing himself, with the rest of his fleet, in such a manner as to enable him to receive the Dutch admiral in a proper position, whenever he should be informed of his coming. Upon his appearance, the count d'Etrées formed the line with incredible alertness, kept close to the wind, and having stretched out the length of the squadron of Zealand, commanded by vice-admiral Barker, began the action the 7th of June at eight in the morning, and fought the enemy with such bravery, that several of their ships were disabled: he had even made the proper disposition to re-tack, and charge thro' Barker's squadron, if the calm which came on had not prevented his glorious design. The duke of York was engaged at the same time with de Ruyter, whilst the earl of Sandwich in the rear attacked the Dutch rear-admiral Van Ghent: but the clouds of smoke being dispersed, and the ships no longer under command in the calm, the two fleets found themselves so intermixed and embarrassed with each other, as greatly heightened the horror of the action, and made it the bloodiest that ever was fought. The gallant earl of Sandwich perished with his ship, that was set on fire by a Dutch fire-ship: soon after which, his death was revenged by that of the admiral of the Amsterdam squadron, and by the loss of two Dutch line-of-battle ships, one of which was taken, and the other sunk. The duke of York shifted his flag twice. In fine, the battle lasted with incredible obliquity on both sides till night, which favoured the retreat of the Dutch: the duke pursued them next day home to their very banks; where, having sheltered themselves, they escaped a total defeat from the hands of a victorious enemy.

We see by the preceding example, how important and necessary it is to be always in readiness to get under fail to receive an enemy; and we may learn by the following example how dangerous it is to wait for an enemy at anchor.

The marshal duke de Vivonne, viceroy of Sicily for the king of France, having intelligence that the enemy, after the engagement off Agulha, had retired to the port of Palermo, resolved to go and attack them in the road. He accordingly embarked on board the Sceptre, commanded by M. de Tourville as commodore, who hoisted an admiral's flag, and arrived the 2d of June 1676 in sight of Palermo, having 27 ships of the line and 25 galleys. He sent his cruisers to reconnoitre the position of the enemy, who brought him intelligence that they consisted of 27 ships and 29 galleys; that they lay at anchor in a line, fronting the fort of Castel-del-Mar, and under its cannon; and were defended on the right by the grand tower and the

Line of  
Battle.

the artillery of the ramparts of the city, and on the left by the batteries of the mole. The marquis de Priuli, chef d'escadre (commandore), was detached with nine ships and five fireships, and the chevaliers de Bretevil and Bethomas with seven galleys, to bear down upon the enemy to the left; all which was executed with so much bravery and resolution, that the vanguard of the enemy were obliged to cut and slip, and run ashore under the batteries of the town, where the fireships burnt three of their ships to the water's-edge: the whole was destroyed by the French with very little loss.

#### CHAP. V. Line of Battle.

I. THE ancients, as already observed, ranged their ships or galleys so as to present them in front to their enemy; because the machines they then made use of were fixed in the heads or prows of their vessels: the same reason now prevails with regard to the galleys, (see the article GALLEY), which are drawn up in the form of a crescent or half-moon, whose ends or horns are opposed to the enemy; in the middle of which is the admiral, from whence he the more distinctly observes the motions of his fleet throughout. The two fleets being thus drawn up, approach each other to a convenient distance; when the engagement beginning at the ends of the half-moon; they extend themselves insensibly till the whole fleet is engaged, and each partakes of the danger and glory of the action. See fig. 4.

EXAMPLE. The famous battle of Lepanto is the most remarkable action of this kind that ever happened. It was fought between the Turks and Christians in the gulph of Lepanto, the 7th of October 1571. The Christian fleet of galleys consisted of 205, large and small; the Turks had near 260: both formed two long lines, each inclining towards the end, where they began the engagement. Don John of Austria, generalissimo of the Christian forces, had placed himself in the centre of his fleet, and gave the command of his right wing (van) to the famous admiral Doria, and his left (rear) to Michael Barbarigo. The bashaw Pertau, general of the Turks, had likewise placed himself, together with the bashaw Ali, in the centre of his fleets; and gave the command of his right wing to the bashaws of Alexandria, Mehemet and Siroco, and his left to Uluchiali, governor of Algier. The action began at two o'clock in the afternoon; which was first brought on by rowing towards each other with all their might, accompanied all the time with the most alarming shouts and outcries. The left wing of the Christians performed wonders: Barbarigo attacked the Turks with such incredible fury, that the barbarians could no longer resist the incessant fire of the Christians, but precipitately ran themselves ashore on the neighbouring coast, some plunging into the sea, others leaving their galleys to the bravery and mercy of the conquerors. The defeat was so general, that the Turks escaped with only 30 galleys. There perished in this day's bloody action 25,000 Turks; 3500 prisoners were taken, and 130 galleys; the Christians lost on their side 10,000 men, and 15 galleys: they might have then destroyed the whole Ottoman power, had they known how to have made the greatest advantage of so glorious a victory.

Line of  
battle.

II. In an engagement of men of war, the fleets are drawn up in a line of battle on two parallel lines upon a wind. The ships keep close to the wind on the line they are formed in, and are commonly at a cable's length distant one from the other, the fire-ships, transports, tenders, &c. keeping at half a league's distance on the opposite side of the enemy. Thus the fleets AB, CD, (fig. 5.) that are engaged, are ranged under an easy sail with their larboard tacks on board; and the fireships EE of the fleet AB are to windward, the fireships FF are to leeward of their fleet CD.

EXAMPLE. This form was observed, for the first time, in the famous battle of the Texel, where the duke of York defeated the Dutch on the 13th of June 1665.

We, as well as the French, owe the entire perfection of this order to his royal highness. The English fleet consisted of 100 ships of the line; that of Holland was more numerous, though not in three-deck ships: the two fleets found themselves nigh each other early in the morning, the wind being at S. W. they ranging themselves in two lines at S. S. E. each extending itself about five leagues in length, the English having the advantage of the wind. The duke of York, commander in chief of the English fleet, had placed himself in the centre, and gave the command of the van-guard to prince Rupert, and the rear to lord Sandwich. The Dutch admiral Opdam had opposed himself in the centre of his fleet to the duke of York, and vice-admiral Tromp against prince Rupert. They cannonaded each other from 3 o'clock in the morning till 11, with great fury and intrepidity, the victory still declaring for neither side. The Dutch took one English ship, which too rashly attempted to force through their line: but they fall off to S. E. found the English fire greatly annoyed them. About 11 o'clock the duke of York bore down with his whole line upon the enemy, he himself bearing down at the same time upon Opdam; this disposition and resolution of his royal highness elevated the courage and spirit of both parties to an almost invincible obstinacy. The terrible roaring of the cannon, wrecks of ships, fall of masts, together with a thick smoke intermixed with flashes of fire from the ships that blew up, heightened the horror of this action beyond the power of imagination. It is related of admiral Opdam, that, amidst all this scene of carnage and destruction, he sat with the greatest composure on his poop, viewing, and giving orders to repair as much as possible the damage and disorder he sustained from the duke of York; animating his men all the time both by his words and actions. At two o'clock in the afternoon, his royal highness made the signal for the whole line to bear down together upon the enemy; which obliged the Dutch to alter their disposition of keeping close to the wind any longer. Opdam only, with one of his ships, called the *Prince of Orange*, of three decks, still kept his station; but soon after, Opdam having received a whole broadside from the duke of York, his ship blew up, without its being ever known by what accident, though five of the men were saved. The Dutch, having already lost many of their ships, and seeing their admiral blow up, put before the wind for the Texel; the duke of York pursuing them with great resolution and bravery to the

Plate  
CXCVII.

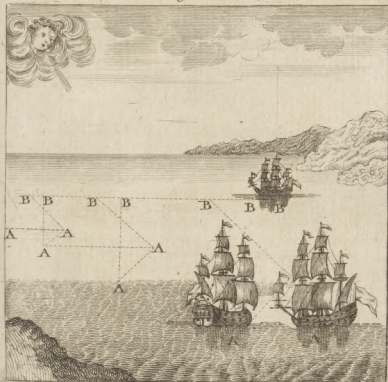
*Fig. 1.*



*Fig. 3.*



*Fig. 2.*



*Fig. 4.*



*W. Bell sculp.*

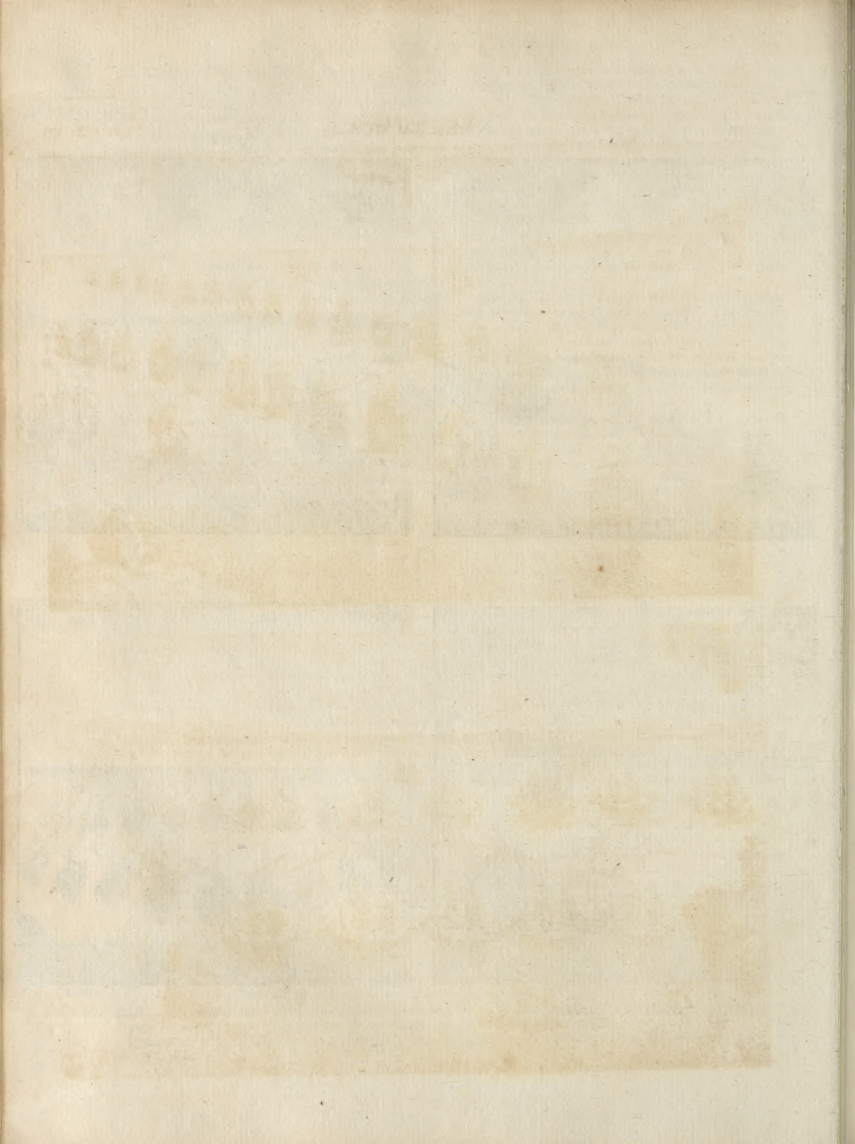
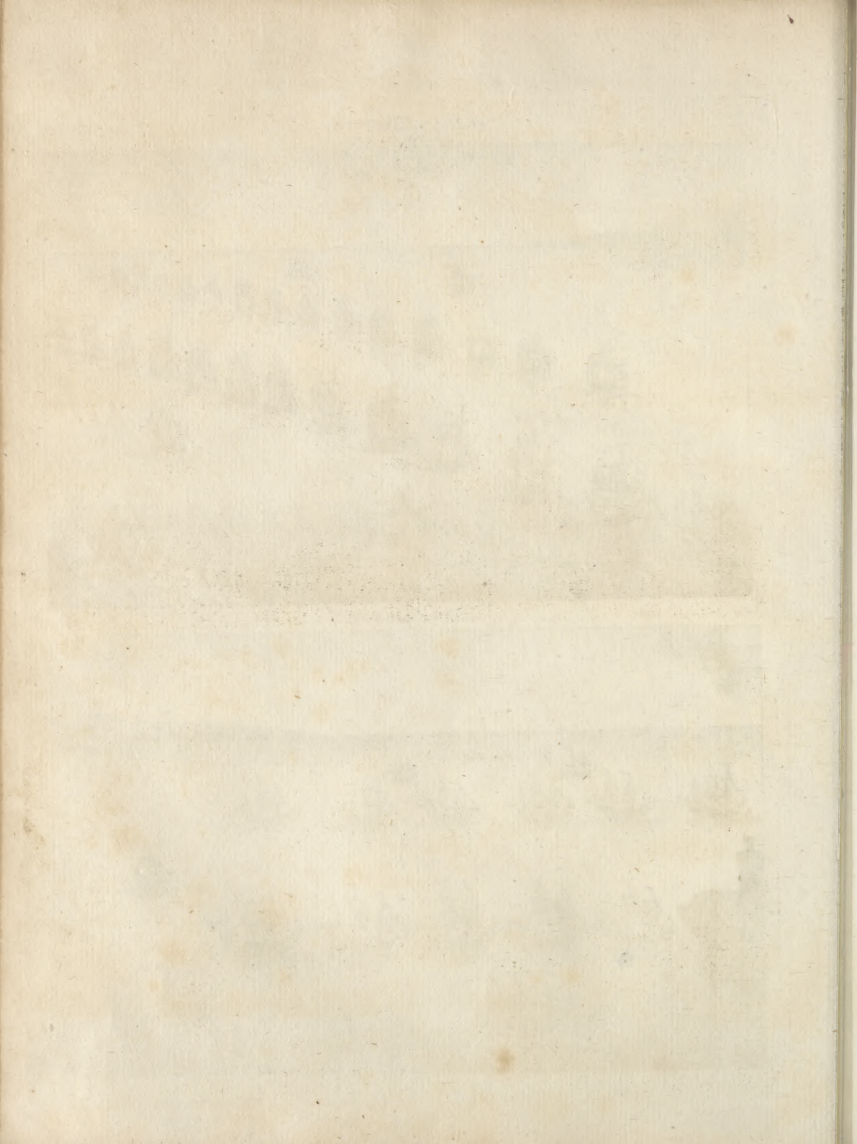


Fig. 1.

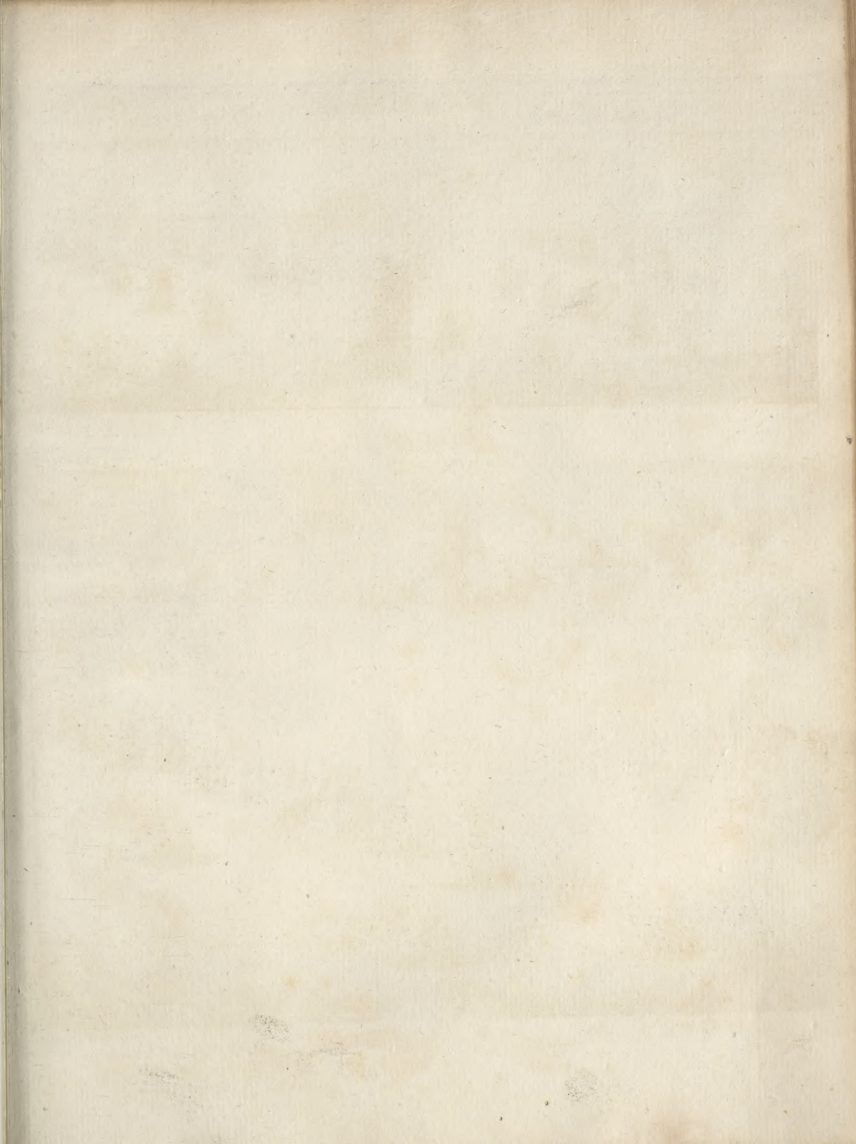


Fig. 2.









*Fig. 8.*



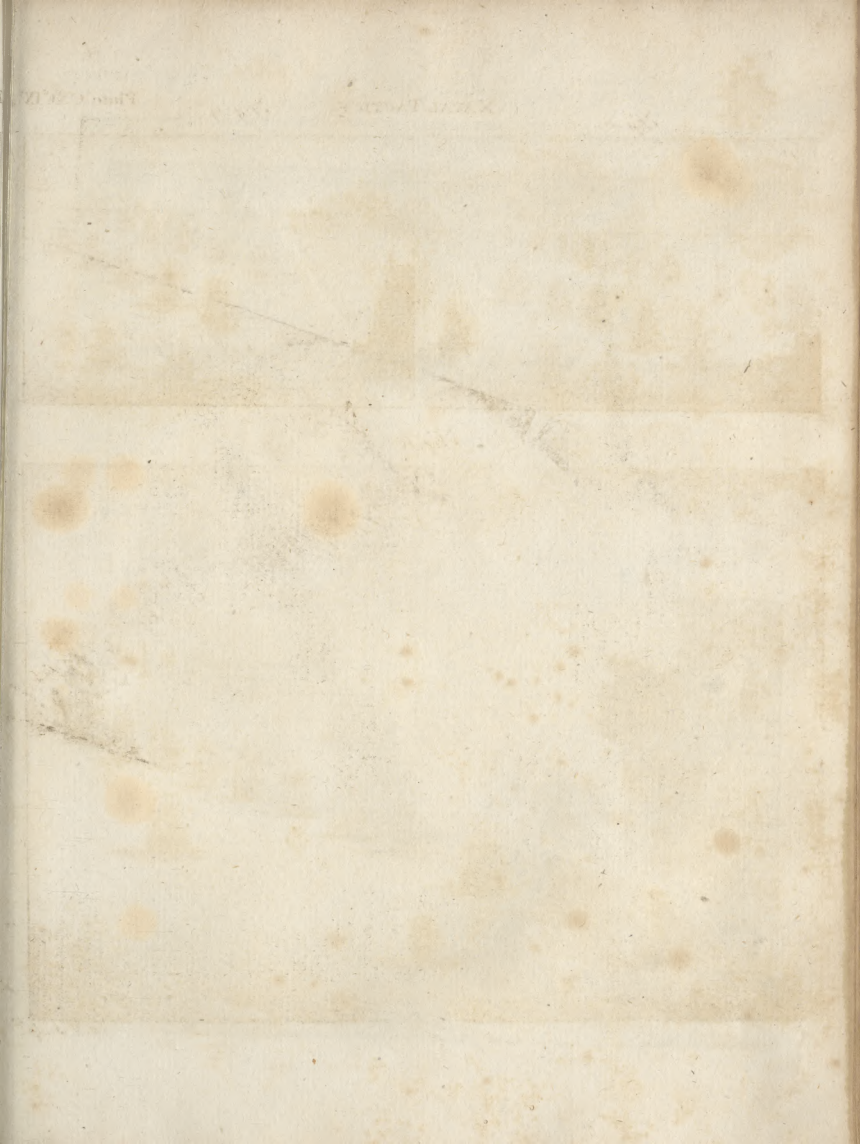
*Fig. 9.*

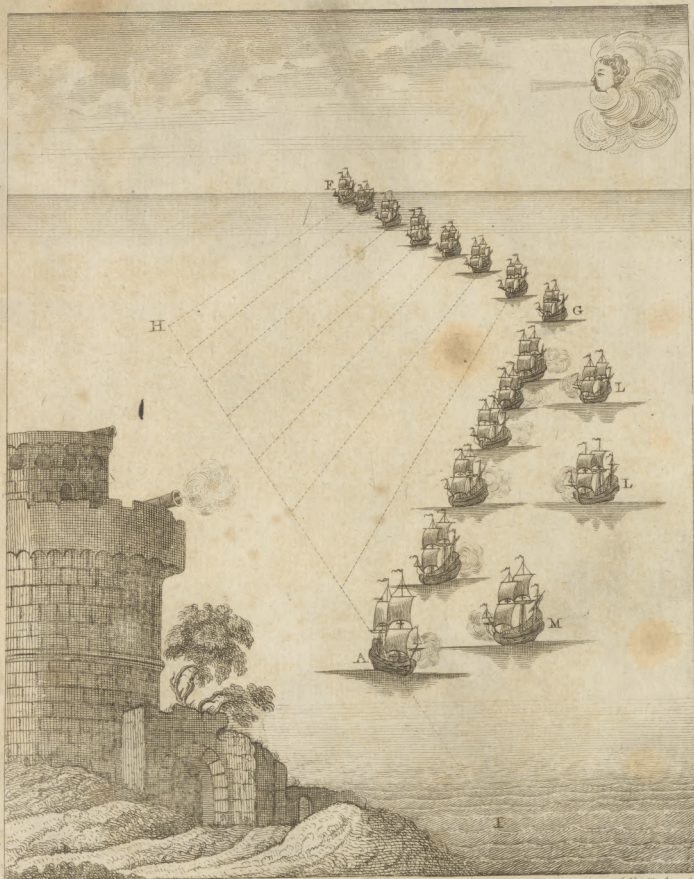


*Fig. 10.*



*A Bell Sulp.*





A Fleet to  
Windward.

the very entrance of their port: he took, burnt, and destroyed, 22 ships of the line, 20 of which were from 50 to 80 guns; and gained over them the most glorious victory that was ever obtained at sea. The whole action cost him but one man of war, with the loss of 300 or 400 men.

III. Before we enter into action, or form the line of battle, we must consider first the advantages or disadvantages of being to windward or to leeward.

#### Advantages of being to WINDWARD.

1. THE fleet to windward can edge down to the enemy, when and as near as it shall think convenient: consequently regulates the time and distance most advantageous to come to action.

2. If the fleet to windward is more in number, it may easily detach some ships to send after the rear of the enemy, which must undoubtedly throw them into confusion. Thus, the fleet AB being more in number than the fleet CD, may easily detach the ships EF to double upon the rear D, which cannot long resist such superior fire; therefore must give them an opportunity (with the rest of the ships that will of course join them) to range along the whole length of the enemy's line. This is an advantage the fleet to leeward cannot have, let it be ever so numerous; for the rear of its line will be in a manner useless.

EXAMPLE. The advantage of the wind could never be more favourable than it was in an action off Agulha, the 22d of April 1676, when the combined fleets of Spain and Holland avoided a total defeat by having the advantage of the wind. The French fleet, commanded by Mons. Du Quesne, consisted of 27 ships of the line. The marquis of Almira, lieutenant-general, commanded the van-guard; and Mons. Gabare, chef d'escadre (commodore), the rear. The enemy's fleet consisted of about the same number of ships, but had besides 9 galleys; De Ruyter commanded the van-guard, the Spanish admiral was in the centre, and the Dutch vice-admiral commanded the rear. The two fleets met off Agulha early in the morning; but the enemy kept their wind till 4 o'clock in the afternoon, when de Ruyter bore down upon the French rear in good order, where they received him in the same manner with equal intrepidity: there were many ships disabled on both sides. The marquis d'Almira was carried off by a cannon-ball, and de Ruyter was mortally wounded. These two accidents caused some disorder in the van of the fleet; but the chevalier de Vallballe, chef d'escadre, supplying the place of the marquis d'Almira, behaved so remarkably gallant, that he was just upon the point of taking and destroying a part of the enemy's fleet, had not their galleys most opportunely taken their disabled ships in tow, and saved them from falling into his hands. The action began later in the centre, and had scarcely reached the rear guard: the enemy having the wind, had availed themselves so well of that advantage, that they continued the engagement no longer than was necessary to save their honour; waiting for the approaching night to retire from the pursuit of the victors.

3. If any of the ships of the fleet to leeward should be disabled, whether in the van or rear, or even in the centre, the fleet to windward may with

the greater ease send down their fire-ships upon them, or send a detachment after any part of the flying enemy.

4. We must likewise attribute, amidst other advantages of being to windward, that of being sooner freed from the inconvenience of the smoke of the enemy as well as of our own. 1. The wind repelling back again the smoke of the cannon into the ship, so greatly incommodes those quartered at the guns, as totally to deprive them for some time of the sight of the enemy. 2. The same smoke must likewise much embarrass the sailors in working the ships; as it is often found by experience, that the sails and rigging are set on fire by the combustible matter and fiery particles incorporated with the smoke; besides many other fatal accidents incident to ships in that unhappy situation.

#### Advantages of being to LEEWARD.

It must be acknowledged, that a fleet to leeward has likewise great advantages; and there are who maintain, that the advantage of being to leeward is at least equal to that of being to windward. But when they consider all circumstances more attentively, they will find the advantage of being to windward the greatest a fleet can possibly have, whether superior or inferior to the enemy: though we must allow at the same time, that, on some extraordinary occasions, it may be more advisable to get to leeward if we can, that is, when it blows hard, and the sea runs so high, that the weather fleet cannot open its lower tier, when obliged to engage a greater number of ships, or in an action between two single ships. But still, in an engagement between two fleets, in moderate, proper weather for engaging, that which has the weather-gage has greatly the advantage.

1. The fleet to leeward fire to windward, and consequently the ships may make use of their lower tier, without being under any apprehensions that a sudden squall of wind should overpower them, by the water rushing in irresistibly between decks: an advantage (in some measure) the English fleet under Sir Edward Hawke, had over the French fleet commanded by Mons. Conflans, in that ever-glorious and memorable action off Belleisle, the 20th of November 1759, where they fatally experienced the difference of our superior skill, undaunted resolution, and seamanship. This circumstance is certainly the greatest advantage a fleet to leeward can have, especially when it blows hard, with a great sea. One can hardly conceive the confusion and disorder sudden gusts of wind occasion between the men between decks, when the waves come pouring in, and lay a ship upon her broad-side, so as often to endanger her overturning, or going to the bottom before the ports can be secured.

2. The fleet to leeward can easier cover any of their ships that should be disabled in action, which must greatly embarrass the fleet to windward to effect, without running the risk of being destroyed by the enemy in attempting it; however, these are disasters which both are equally subject to.

3. The fleet to leeward may easier make a retreat if beaten; whereas the fleet to windward cannot so well escape, without being reduced to the necessity of forcing its way through the enemy's line, which must be attended with the most fatal consequences.

It must be acknowledged, that a fleet which puts

before the wind runs a great risk, if the enemy is in a condition to pursue it: but then there are some circumstances wherein the fleet to leeward may boldly venture to crowd away before the wind; that is to say, when night approaches, the wind freshens, the sea rises, or the enemy is embarrassed with a convoy, which may prevent their pursuing them.

EXAMPLE. The allies availed themselves of these advantages, in the year 1689, off Bantry. The count de Chateau-Renaud commanded the French fleet of 24 ships of the line, and convoyed 3000 men to Ireland, with a great quantity of stores, provisions, and ammunition. My lord Herbert, who commanded a squadron of much the same force, having intelligence that the French landed their troops in Bantry-bay, resolved to go and attack them there, not doubting but he should find them in some disorder: but the count had taken his measures so prudently, and was so well prepared, that he advanced in good order to receive the English, and attacked them with so much bravery, that he soon obliged them to crowd away all the sail they could make before the wind; pursuing them till night put an end to the chase: and the count, having thus happily landed his troops, returned to Breft, where he received the just applauses due to his successful expedition; having in eleven days carried succours into Ireland, beat the enemy, took a considerable convoy, and reconducted back again his fleet to Breft in good order and condition.

IV. But to return to the explanation of the line of battle: We have already observed, that fleets in action ought to be ranged on two parallel lines; for, if formed otherwise, by inclining in the van and rear, the headmost and sternmost ships will be engaged, whilst the ships in the centre will be out of the reach of each other's guns: a consequence too obvious to need any demonstration.

The ships ought to keep at a cable's length from each other, or closer, if judged convenient or necessary: otherwise, if too far asunder, one ship of such line will be exposed to the fire of two ships at a time, from the closer and more regular line of the enemy.

The size of the ships is likewise too important a point not to be properly considered in a line of battle, as it contributes more to its strength than the number of the fleet; for two reasons. 1. A large ship carries more guns, and heavier metal: so that a fleet consisting of such ships is of greater force than a more numerous fleet of smaller ships, though drawn up in a closer line; because they engage the enemy with more, as well as heavier artillery, in the same space. 2. The great ships are stronger timbered, and consequently better able to resist the shot of the enemy; therefore of greater service in action than a fleet of smaller ships, notwithstanding the advantage of a closer line; because that each ship of the former is attacked only by a less number of guns of the latter that can do her any damage.

V. *To form a line of battle from the order of retreat.* Suppose the fleet AGF in a retreating form, to change it into a line of battle, the headmost ship A must haul up upon a wind, and the rest of the fleet,

running large four points on the same tack, will form itself in her wake, or the line IH.

This evolution is so regular, so simple, and short, that it makes this order of retreat preferable to any other; for a fleet that retreats may be often obliged to come to action: it would be then greatly embarrassed, if it could not immediately resume the line again by so easy and regular a method as this. In effect, by way of illustration, let us suppose, that the enemy LLM presses the fleet so close in its pursuit, as to force it to come to an engagement; then the ships that were sailing large, haul upon a wind all together, as soon as possible, on the larboard tack, the head A hauling up at the same time. This manœuvre (method of working) can cause no confusion in the fleet: on the contrary, it then presents its sides with greater advantage to the enemy; and the ships that range themselves upon a wind in the wake of the ship A, will force between two fires the enemy's ships M.

We suppose that the enemy attack only one side; for they will find it difficult in effect to attack both, without running the risk at the same time of being separated: but admit that the enemy did attack on both sides, you may still perform the evolution equally the same; and the ships GF would present their sides to the enemy, as well as when they were sailing large or before the wind.

#### CHAP. VI. *Some necessary Manœuvres before an Engagement.*

##### § 1. *To dispute the Wind with the Enemy.*

1. THE fleet to leeward should avoid extending itself the length of the enemy's line, in order to oblige them to edge down upon theirs, if they intend to attack them; which will be a means, if they still persist in doing so, of losing the advantage of the wind.

It is impossible for a fleet to leeward to gain to windward so long as the enemy keep their wind, without a change happens in their favour. Therefore all that a fleet to leeward can do, must be to wait with patience for such a happy change, which they will undoubtedly avail themselves of, as well as any mistake or inadvertency the enemy may commit in the mean time. And as long as the fleet to leeward does not extend its line the length of the enemy's, it will be impossible for the latter to bring them to action, without running the hazard, by bearing down, of losing the advantage of the wind, which both fleets will be so desirous of preserving.

2. In fine, that an admiral may benefit by the shifts of wind that frequently happen, he must in a manner foresee them; which will not appear so extraordinary to officers of any experience, who know what winds reign most on the coast, or off the head-lands where they may expect an enemy: and though an admiral may be sometimes out in his conjecture, he also as often succeeds so happily as to gain the advantage of his enemy.

Monf. du Quesne, the French admiral, by his superior skill in these particulars, gained a considerable advantage over the Dutch fleet, when he engaged them off Strombolo in the year 1676. He waited till the next day for a shift of wind; which happened in his favour as he forelaw, and gave him an opportunity

To avoid  
or force  
an Action.

ty of tacking to windward of the enemy, and bearing down upon them in good order: an advantage they neglected the day before; which fatal oversight they could never afterwards recover.

3. The disposition or projecting of head-lands, of currents in the Mediterranean, and tides in the ocean, contribute greatly towards gaining the wind of the enemy: for sometimes you may only range a coast along, or keep out in the offing, to gain a few leagues upon a tack; and we may say, we think with justice, that the knowledge of these advantages is as essential to an admiral at sea, as the geography of the several countries, with their woods, roads, course of rivers, &c. he is obliged to march through, is to a general of an army on shore.

4. The fleet to windward ought to keep the enemy as much as possible always a breast of it; because, by doing so, they will preserve the advantage they may have, unless the wind greatly changes against them. They should force them likewise to keep their wind, unless they think it more prudent not to engage; but when that is the case, they should keep entirely out of sight of the enemy.

§ 2. To avoid an Action.

1. THE fleet to windward can never be forced to engage; because it can always continue on that tack, which keeps the enemy at the greatest distance from it, by stretching out upon one tack whilst they continue upon the other.

If the wind was not so subject to change, it would be very easy for the fleet to windward to keep in sight of the enemy, without being under any apprehensions of being forced to come to action; but the inconstancy of the wind obliges the most experienced admirals to avoid meeting the enemy, when they think it improper to engage them. The reason of this maxim is founded upon the impossibility of an inferior fleet's avoiding an action, when in presence for any time of a superior fleet.

2. If the fleet that endeavours to avoid coming to action be to leeward, they will edge away the same as the enemy; but, at the same time, they should not go away right afore the wind, without making their retreat in a half-moon, if in sight of the enemy. So that the fleet to leeward, which is not for engaging, seeing the enemy still persist in chasing them, will bear away as they do, in order to keep them at the same distance.

There are some circumstances in which the fleet to leeward may put afore the wind, without ranging it into the order of a retreat; that is, when it only designs to prolong the engagement, or is resolved to engage the enemy, if they still continue to pursue them to bring them to action. But, except on such extraordinary occasions, the form of a retreat puts the fleet into the best posture of defence, and with the least hazard and danger.

§ 3. To force the Enemy to Action.

AXIOM I. WE may look upon it as a general maxim: "When two fleets of equal force remain long in sight, they may alternately force each other to bring on an action." The following reasons support this maxim.

To double  
an Enemy.

If the fleet that wants to bring on an engagement is to leeward, they must endeavour to keep on that tack which forereaches most upon the enemy, that they may keep them better in view, till the wind may happen to change in their favour.

The least experience at sea will serve to convince us, that it is almost impossible for a fleet that once discovers itself to the enemy, ever to retire or escape, unless it secures itself in some port or harbour; for fleets are generally at sea at a season of the year when the nights are very short, and the days long; so that any stratagems or false courses they may use, will avail them but little to escape the pursuit of a watchful enemy: besides, a fleet would not run the hazard of crowding too much sail by night, for fear of being separated, which may be attended with fatal consequences. A recent example of such conduct happened with *Monf. de la Clue* in 1759, who, by crowding away too much sail at night, to push through the gut of Gibraltar with a strong easterly wind, before morning lost sight of half his fleet, and subjected himself of course, by such imprudence, to fall much the easier victim to admiral *Boscawen*, who was in close pursuit of him with his whole squadron, and engaged him the next day with a superior force; which obliged the French admiral to make a running fight, tho' it availed him but little, as five out of his squadron were burnt or taken on the coast of Portugal.

AXIOM II. It is scarcely possible for a much inferior fleet to remain long in presence of an enemy, without being forced to an action. 1. A fleet that is superior in number may send a detachment of its best cruisers after the flying squadron, and soon bring it to action. 2. It may divide itself into three squadrons, leaving a considerable interval between each; then, whatever course the enemy may take to escape, one or other will be always ready to intercept it.

The only resource an inferior squadron can have in such circumstances is, to bear away in the form of a half-moon: though even then, it can have no great hopes of avoiding an engagement, if the enemy persists in chasing it to bring it to action, unless they steer for some harbour or friendly asylum to secure themselves in.

COROLLARY. We may from all this draw the following conclusive inference, that it is almost impossible for an inferior fleet, under any pretext whatever, to continue long in the presence of one greatly superior to it, without being forced to action.

§ 4. To double an Enemy.

To facilitate this, the superior fleet must endeavour to stretch out the length of the enemy's line, and at the same time, leaving ships a-stern, to close and double upon that of the enemy's, and force them between two fires.

1. If the superior fleet is to windward, it may so much the easier double its rear upon that of the enemy's, and force it between two fires; and even if it should be to leeward, it should likewise leave some ships a-stern of it, because of the wind's often changing during the action; besides, the fleet to leeward may insensibly edge away in the heat of the engagement, to give its rear an opportunity of doubling upon the enemy, by immediately luffing up close to the

To avoid  
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bled.

wind again.  
2. There are who maintain, that the enemy's line should be doubled a-head rather than a-stern: because, say they, if the enemy's van is once put into disorder, it will of course fall a-stern upon the rest of the line, and throw it into confusion. But, on the contrary, it seems plain, that the ships will be less exposed, and find it safer to double upon the enemy's line a-stern: for if a ship should be disabled a-head, it does not appear how she can recover her own line again; whereas if a ship should be disabled in attempting the same in the enemy's rear, she cannot be attacked by any of their line, without exposing themselves at the same time to the fire of two ships; therefore may remain a-stern out of danger, till she has repaired her damages again.

Plate  
CXCI.  
fig. 8.

Fig. 9.

3. It seems equally clear, that if the ships E, M, of the fleet CD, had doubled the head A, they would run a great hazard of being destroyed: for if the ship E should be disabled, how can she recover her own line again? how easy might the enemy destroy her? On the contrary, if the ships LN, of the fleet FG, have doubled the rear I of the enemy, and the ship L should be disabled, she may remain a-stern, without being under any apprehension from the rear I, which is already hard pressed by the ships G, N.

Nothing can illustrate this method of working a fleet better than the famous engagement off la Hogue in the year 1692, between the count de Tourville and admiral Ruffel. The French, having the wind, bore down in good order upon the English: but, being at the same time so much inferior in number, it was impossible for them to extend their line the length of the enemy's; therefore could not prevent the English from extending their rear a great way a-stern of the French, which made their line so much the longer in attempting it, and consequently the ships wider asunder, (a great disadvantage against a close line): The wind, which was at first S. W. changing to the N. W. gave the rear of the English an opportunity of still closing its line more, and doubling upon the French; so that the count de Tourville with his division soon found himself surrounded by his enemies on all sides; in which unlucky situation he distinguished himself with the greatest bravery and resolution imaginable, tho' overpowered by numbers, whose great superiority of force could be no longer resisted.

#### § 5. To avoid being doubled.

To prevent any of the enemy's line from doubling upon your's, you must not suffer them to extend any of their ships beyond your rear; in order to which, there are several methods to be taken when your fleet is inferior in number.

Fig. 10.

1. If you are to windward, you need not extend your line the length of the enemy's van, but attack their second division F with your van A; by which means their first division FG will be in a manner useless; and if they should stretch out a-head to tack upon you, they will lose too much time, and run the risk of being separated by the calm which generally happens in the course of a sea-engagement, occasioned by the continual discharge of cannon on both sides; you may even leave a great opening in the centre E, provided you take the necessary precautions to prevent

your van-guard from being cut off: and thus, however inferior you may be in number, you will have it in your power to interrupt the enemy's line from extending itself beyond, or a-stern of, your rear.

To avoid  
being dou-  
bled.

EXAMPLE. Admiral Herbert's method of ranging his fleet, when he engaged the French off Beachy-head, in the year 1690, was generally approved of. He had some few ships less than the enemy, and was resolved to use his utmost efforts against their rear; to effect which, he ordered the first division of the Dutch to bear down upon the second division of the French, at the same time opening his fleet in the centre, leaving a great space a-breast of the main body of the enemy. He then closes his rear, which he opposes to theirs, keeping himself with his division at some distance a-breast of the centre: then closing his ships as much as possible, he opposes them to the enemy's rear, at the same time relieving his own division to attack the French, if they should attempt to push through the opening in the middle, in order to double upon the Dutch. By this method (which shewed great forethought and experience) he rendered the enemy's first division almost useless, because of its being obliged to stretch out a long way a-head to tack upon his van: and the calm which afterwards came on had in a great measure deprived it of partaking of the danger and glory of the action.

2. If the inferior fleet is to leeward, you might leave a greater interval in the centre and less in the van; but then you should have a small corps de reserve of capital ships and fire-ships, that the enemy may not take the advantage of the intervals in your fleet to cut off your line.

3. There are some again for giving it as a general rule, that the commanding officers of the inferior fleet should oppose themselves to the respective general officers of the enemy; by this means several of their ships will remain useless in the intervals, and will be rendered incapable of doubling upon you.

This method has its inconveniencies, because the van and rear of each division is exposed to the fire of two ships at a time, and does not secure the last division from the hazard of being doubled by the enemy's rear; but, to remedy this, you may place the larger ships in the van and rear of each division, and order it so that the last division may not have it in its power to extend its rear a-stern of yours.

4. Again, others will have it, that the three squadrons of the inferior fleet should attack each a squadron of the superior fleet; observing at the same time, that each squadron extends its line far enough to prevent the opposite line from leaving any ships a-stern of it, but rather a-head.

5. In fine, there are who rather choose, that the inferior fleet should stretch its line so long, as to leave a great distance between the ships, that it may extend its line the length of the enemy's. But this seems to be the worst method that can be taken; because it gives the enemy's fleet all the advantage it can desire of exerting its whole force upon the inferior line: tho' it must be allowed, upon certain occasions, this method would be very proper to follow; such as, when the enemy's ships, though more in number, are not of such force and weight of metal as the ships of the inferior fleet.



*Fig. 11.*



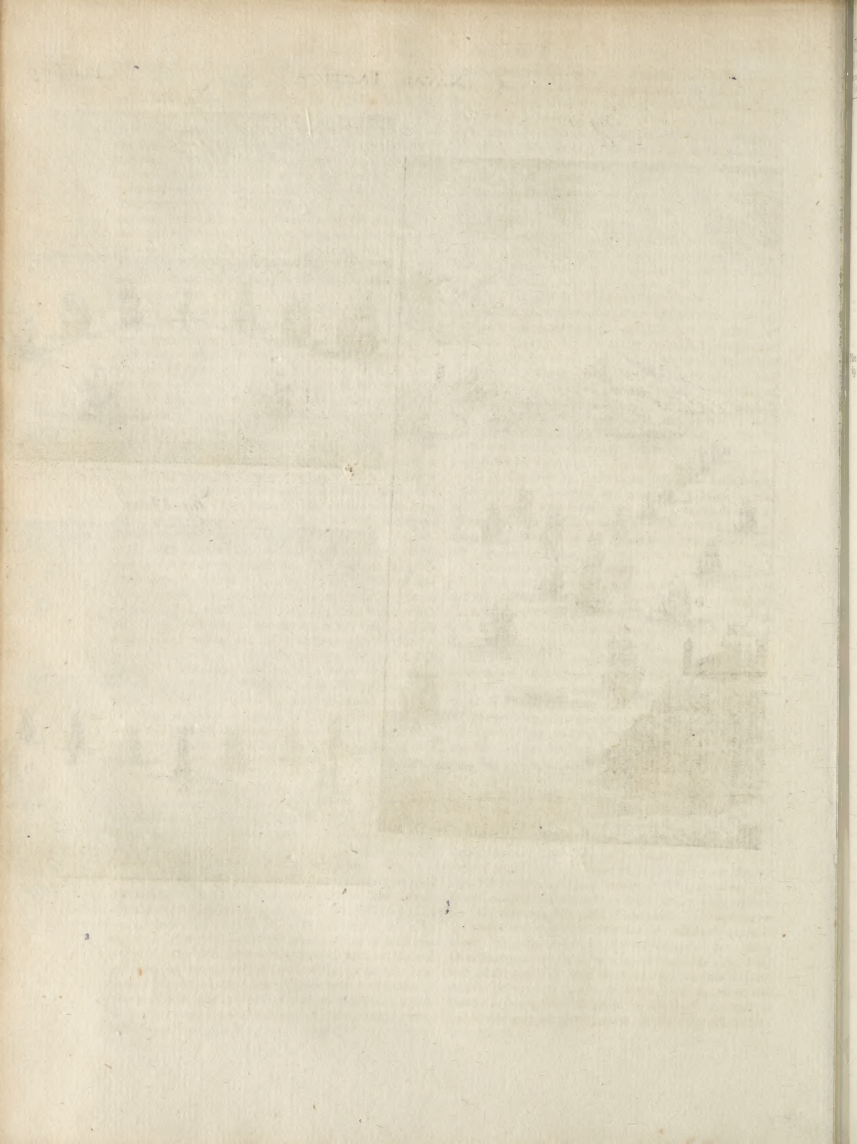
*Fig. 12.*



*Fig. 13.*



*A Bell*



§ 6 To receive a Fleet that bears down upon you.

THE fleet to leeward seeing the enemy bear down upon it, will of course range itself, as expeditiously as possible, into a line of battle, by edging away a little, to gain as much time as may be necessary to form the line without confusion. They should not omit at the same time leaving some small intervals between the divisions, that the fleet may be the better able to distinguish, and have more room for action: then each commander will exert his utmost to keep his ship a-breadth of any ship of the enemy's that happens to fall to his lot; either by making more or less sail, or even tacking, (if absolutely necessary), to preserve his station with regard to the enemy.

§ 7. To force through the Enemy's Line.

1. WE find in the several relations of the wars between the English and Dutch, that they had often alternately traversed and charged through each other's fleets; that is to say, the fleet to leeward CHD, having stretched out a little a-head, tacked upon the enemy AB, and forced through their line at E, then re-tacking upon them immediately at C, on the other side, gained the wind of them; but then again, the others, in their turn, regained the same advantage of them, and cut them off from their line. Thus they mutually traversed each other, cutting off and destroying one another's ships, with an invincible obstinacy and bravery not to be described.

This manner of fighting and working a fleet is equally daring and hazardous, and requires the most consummate ability as well as experience to succeed in it so happily as the count d'Etrécs did in an engagement with the Dutch in the Texel in the year 1673. He traversed and charged through the squadron of Zealand, gained the wind of them, and threw them into such disorder, that the victory, which was before doubtful, now manifestly declared in his favour.

2. It should seem easy for the fleet to windward to hinder the enemy to leeward from forcing through their line; which, whenever they attempted, the other fleet may tack at the same time all together, and thereby effectually prevent them from succeeding.

3. It does not therefore appear why we should be under any apprehension from a fleet that attempts to force through our line. It even seems that it should never be put in practice but in the following circumstances: Such as being sometimes obliged to it, to avoid a greater evil; if the enemy should leave a great opening in the centre, and render part of your fleet useless; or if a number of ships should be disabled, &c.

4. You are sometimes obliged to traverse the enemy's line to disengage some of your own ships which may happen to be cut off; in that case, you must boldly risk something, at the same time not forget the necessary precautions. 1. To close your ships as much as possible. 2. To make all the fail you can, without waiting to attack the enemy as you force through their line. 3. As soon as you have got through, you should tack again without loss of time, lest the enemy should stand on upon the same tack with the ships that had broke through their line.

Admiral de Ruyter put this fort of traverses in practice to the greatest advantage, when he beat the Eng-

lish fleet under general Monk in the year 1666, three days successively, on the north of England.

## CHAP. VII. Of a general Action between two Fleets.

### § 1. General Observations.

THE engagement will not begin before the admiral makes the signal, unless an action is infensibly brought on by some unavoidable circumstances in the line or position of the van or rear of both fleets, in forming or approaching each other: the admiral, in such case, will make the proper signal for the van or rear, by the distinguishing flag of either of these divisions; which will undoubtedly regulate the necessary manœuvres of the rest of the fleet through the whole line.

The admiral in action carries but little fail: in which, however, he must conduct himself by the motions of the enemy; the ships always observing to keep close in the line; and wherever they do not, the ships which immediately follow, should pay no regard to those that precede them, if they should unguardedly leave too great an opening from the rest, unless ordered so to do by signal from the admiral.

The ships ought to be particularly careful not to fire till they find themselves nigh enough for the line to do effectual execution; otherwise it will be but expending a quantity of ammunition to very little purpose. They ought principally to level well their guns, without that hurry or confusion too often practised in firing broadsides; and from which so little advantage in general is derived, to answer the end proposed, that of defeating the enemy, which may be much sooner accomplished by a more regular and steady fire, constantly kept up without intermission, the better to embarrass their line, and divert their attention, more than broad-side and broad-side, with some intervals between (as must naturally happen), will ever effect. We ought to be convinced of this general truth, That of all actions, a sea-fight (except in the article of boarding) should be conducted with the least hurry or precipitation in order to succeed.

A captain must not quit his post in the line upon any pretence whatever, unless his ship should be so greatly incommoded as to render her incapable of continuing the action: the little fail a fleet is under at such time, in general, may give the ships, though damaged in their rigging, &c. time enough to repair their defects, without causing an unnecessary interruption in the line, by withdrawing out of action, when their service might perhaps be of the utmost importance to the rest of the fleet.

A captain, through too impetuous a desire of distinguishing himself, ought never to break the order of the line, however inviting the advantage of an attack might then appear to him to secure success: he must wait with patience the signal from the admiral or commanding officer of his division, because it is always more essential to preserve and support a close line in action, as it constitutes the principal strength of a fleet in general, than to attend to a particular attack between two ships, which commonly decides but little with regard to the whole, however glorious in appearance, unless with a view at the same time of taking or destroying a flag-ship of the enemy's, and where success alone, even then, can justify the attempt.

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The two immediate seconds to the admiral ought to direct part of their fire against the enemy's flag-ship, or any other that may attack their admiral; so that their chief attention should be employed more in his defence than in that of their own proper ships, as they must sacrifice every other consideration to the honour of their flag.

The same attention must likewise be paid to any other ship that may find herself engaged with one of the enemy's flag-ships; the next to her a-head and a-stern should serve in that respect as seconds, by dividing part of their fire against such flag-officer, in order to make him strike the fooner.

If any flag-officer stand in need of being succoured, he will of course make a signal for the corps-de-reserve; or if there should be none, he will signify the same to his division; on which his two seconds, with those nearest him, will close in to cover him, and continue on the action: the frigates of his squadron will likewise be ready to give him the necessary assistance; and, if he should still continue the attack, he will be in a particular manner supported by his whole division.

Those ships that happen to be most exposed to danger, will naturally make the ordinary signals upon the occasion, if they should receive any hurt or damage, in order to be supported by such in the line as are within reach of them.

### § 2. To detach from the Line a Corps-de-reserve.

WHEN a fleet is so far superior in number as to be able to extend itself both a-head and a-stern considerably beyond the enemy's line, if then the admiral should think it expedient, that such ships as may not be a-bread of the enemy, should detach themselves from the line, and form to windward or to leeward into a body of reserve; those of the second division of the van-guard, or those of the second in the rear, will immediately detach themselves from the body of the fleet, after the repetition of the signal from the commanding officers of their divisions, and place themselves in a line with the frigates nearest a-bread of the centre of the fleet, if to windward; or if to leeward, somewhat a-head of the same; being careful at the same time to keep within reach of observing distinctly all the signals and motions of the fleet, to be the readier at hand to re-place such of the ships as may happen to be dismasted or drove out of the line, where all intervals must be properly strengthened and carefully filled up again without loss of time.

The oldest captain, after the senior officer who commands the reserve, ought to relieve the first, or close that part of the line where the disabled ship has been obliged to quit; and so on successively of the rest.

The commanding officer of the body of reserve will not be detached with the whole corps, unless on some pressing occasion to fortify the line, where such reinforcement is immediately necessary; if to defend one of the flag-officers of the three squadrons, he will be followed by the next senior officer of the reserve, who was not before detached, in order to place themselves as seconds, the first a-head and the other a-stern of the flag they are to support, without any diminution of the honour of his own proper seconds at the same time, as they are only called in thro' necessity on that emergency, being not engaged before, and conse-

quently better able to assist and support the admiral; their duty being likewise to exert their utmost efforts in attacking or boarding (if possible) the enemy's flag-ship to force him to yield, except they are particularly ordered off to some other quarter or part of the line.

The admiral will sometimes order the whole body of reserve to reinforce one of the three squadrons of the fleet, as he may see occasion; which when he does, the corps must make all the fail it can, that each ship may place herself, successively, the first in the first interval, the second in the second, and so on throughout; but if the admiral should want only part of that body, he will make the signal accordingly.

If the admiral, commanding an equal or superior number of ships to the enemy, should judge it necessary to have a small reserve of one or two ships for each of the three squadrons of the fleet, the ships for that purpose in each of the three bodies are made known by signal for the reserve; they will immediately draw out of the line upon hoisting the same, and form themselves on the line with the frigates, at a convenient distance from their commanding officer: that is to say, the first a-bread, and under cover of the headmost second; and the other a-bread, and under cover of the admiral, to be in readiness to run in between him and one of his seconds, to enable him the better to continue on the action with fresh vigour, and press the enemy with unremitting ardour to strike as soon as possible.

The corps-de-reserve is generally formed at the same time with the line, to prevent any irregularity that may happen on leaving any intervals or openings; tho' the admiral may, if he thinks proper, draw ships out of the line during the action, to form a body of reserve, according to the time or circumstances of his situation, &c.

When the admiral finds he has no further occasion for his body of reserve, he will make proper signals for such ships to resume their respective posts in the line again; the corps-de-reserve will always repeat the signals which regard themselves particularly.

### § 3. Of Boarding.

WHEN the admiral shall judge it necessary or convenient to prepare the fleet for action, he will make the signal proper for the occasion, and the fleet will at the same time make the necessary disposition for boarding. If the admiral design to board any of the enemy's ships, he will undoubtedly make the proper signal for the whole fleet, a particular squadron, or, in fine, for a particular ship, by the different position of the signal, and the distinguishing mark of such squadron or division, or particular pennant of such ship.

If any captain in the fleet think he can board with success one of the enemy's ships, he will signify the same to the admiral by hoisting the boarding flag, together with his particular pendant, to be more plainly distinguished; the admiral, in return, will make the proper signal of approbation, or otherwise, if he disapprove the attempt, by letting fly at the same time that ship's particular pennant, that she may observe the signal the better.

When a captain seems to express an ardent desire of distinguishing himself by boarding one of the enemy's ships, he ought to consider well the ill consequences that

that might perhaps attend such enterprize, if he fail of success; for the breaking the order or disposition of the line, by quitting his post, may be of much greater disadvantage to the whole, than any advantage arising from his victory, except that over a flag-ship.

#### § 4. *The Fire-ships to prepare.*

WHEN the admiral makes the signal for his fleet to prepare for action, the fire-ships will at the same time get ready their grappling-irons, fire-engines, &c. for boarding, and will likewise dispose all their combustibles into their proper channels of communication, &c. as soon as possible after the action begins: all which, when ready, they will take care to make known by signal to the particular division or Squadron they belong to, and they of course will repeat the same to the admirals.

The fire-ships must be particularly careful in placing themselves out of the reach of enemy's guns, which they may do a-breadth, and under shelter of their own ships in the line, and not in the openings between the ships, unless to prevent any of the enemy's ships that should attempt to force through their line; when they must, in such case, use their utmost efforts to prevent them. They ought always to be very attentive to the admiral's signals, as well as those of the commanding officer of the particular Squadrons they belong to, that they may lose no time when the signal is made for them to act, which they must quickly answer by a signal in return.

Although no ship in the line might be particularly appointed to lead down or protect the fire-ships, besides the frigates already ordered by special appointment to attend that service; yet notwithstanding, the ship a-head of which the fire-ship passes in her way to the enemy is to escort her, whatever division she may belong to, and must assist her with a boat well-manned and armed, as well as any other succour she may stand in need of: the two next ships to her must likewise give her all necessary assistance. The captain of a fire-ship is to consider, in short, that he is answerable for the event, in proportion as he expects to be honourably rewarded, if he succeed in so daring and hazardous an enterprize.

#### § 5. *Particular Description of the Economy of a naval Engagement.*

SINCE a general engagement of fleets or Squadrons of men of war is nothing else than a variety of particular actions of single ships with each other, in a line of battle; it may not be improper to begin by describing the latter, and then proceed to represent the usual manner of conducting the former.

I. The whole economy of a naval engagement may be arranged under the following heads, viz. the preparation, the action, and the repair, or refitting for the purposes of navigation.

1. The preparation is begun by issuing the order to clear the ship for action, which is repeated by the boatswain and his mates at all the hatchways, or stair-cases, leading to the different batteries. As the management of the artillery in a vessel of war requires a considerable number of men, it is evident that the officers and sailors must be restrained to a narrow space in their usual habitations, in order to preserve the in-

ternal regularity of the ship. Hence the hammocks, or hanging-beds, of the latter are crowded together as close as possible between the decks, each of them being limited to the breadth of fourteen inches. They are hung parallel to each other, in rows stretching from one side of the ship to the other, nearly throughout her whole length, so as to admit of no passage but by stooping under them. As the cannon therefore cannot be worked while the hammocks are suspended in this situation, it becomes necessary to remove them as quick as possible. By this circumstance a double advantage is obtained: the batteries of cannon are immediately cleared of an encumbrance, and the hammocks are converted into a sort of parapet, to prevent the execution of small-shot on the quarter-deck, tops, and fore-castle. At the summons of the boatswain, *Up all hammocks!* every sailor repairs to his own, and, having stowed his bedding properly, he cords it up firmly with a lashing or line provided for that purpose. He then carries it to the quarter-deck, poop, or fore-castle, or wherever it may be necessary. As each side of the quarter-deck and poop is furnished with a double net-work, supported by iron cranes fixed immediately above the gunnel or top of the ship's side, the hammocks thus corded are firmly stowed by the quarter-master between the two parts of the netting, so as to form an excellent barrier. The tops, waists, and fore-castle, are then fenced in the same manner.

Whilst these offices are performed below, the boatswain and his mates are employed in securing the fail-yards, to prevent them from tumbling down when the ship is cannonaded, as the might thereby be disabled, and rendered incapable of attack, retreat, or pursuit. The yards are now likewise secured by strong chains or ropes, additional to those by which they are usually suspended. The boatswain also provides the necessary materials to repair the rigging, wherever it may be damaged by the shot of the enemy, and to supply whatever parts of it may be entirely destroyed. The carpenter and his crew in the mean while prepare his shot-plugs and mauls, to close up any dangerous breaches that may be made near the surface of the water; and provide the iron-work necessary to refit the chain-pumps, in case their machinery should be wounded in the engagement. The gunner with his mates and quarter-gunners is busied in examining the cannon of the different batteries, to see that their charges are thoroughly dry and fit for execution; to have every thing ready for furnishing the great guns and small arms with powder, as soon as the action begins; and to keep a sufficient number of cartridges continually filled, to supply the place of those expended in battle. The master and his mates are attentive to have the sails properly trimmed, according to the situation of the ship; and to reduce or multiply them, as occasion requires, with all possible expedition. The lieutenants visit the different decks, to see that they are effectually cleared of all encumbrance, so that nothing may retard the execution of the artillery; and to enjoin the other officers to diligence and alertness, in making the necessary dispositions for the expected engagement: so that every thing may be in readines at a moment's warning.

When the hostile ships have approached each other to a competent distance, the drums beat to arms.

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The boatwain and his mates pipe, *All hands to quarters!* at every lutchway. All the persons appointed to manage the great guns immediately repair to their respective stations. The crews, handspikes, rammers, sponges, powder-horns, matches, and train tackles, are placed in order by the side of every cannon. The hatches are immediately laid, to prevent any one from deserting his post by escaping into the lower apartments. The marines are drawn up in rank and file on the quarter-deck, poop, and fore-castle. The lashings of the great guns are cast loose, and the tomponis withdrawn. The whole artillery, above and below, is run out at the ports, and levelled to the point-blank range ready for firing.

2. The necessary preparations being completed, and the officers and crew ready at their respective stations to obey the order, the commencement of the action is determined by the mutual distance and situation of the adverse ships, or by the signal from the commander in chief of the fleet or squadron. The cannon being levelled in parallel rows, projecting from the ship's side, the most natural order of battle is evidently to range the ships abreast of each other, especially if the engagement is general. The most convenient distance is properly within the point-blank range of a musket, so that all the artillery may do effectual execution.

The combat usually begins by a vigorous cannonade, accompanied with the whole efforts of the swivel-guns and the small arms. The method of firing in platoons, or volleys of cannon at once, appears inconvenient in the sea-service, and perhaps should never be attempted unless in the battering of a fortification. The sides and decks of the ship, although sufficiently strong for all the purposes of war, would be too much shaken by so violent an explosion and recoil. The general rule observed on this occasion throughout the ship, is to load, fire, and sponge, the guns with all possible expedition, yet without confusion or precipitation. The captain of each gun is particularly enjoined to fire only when the piece is properly directed to its object, that the shot may not be fruitlessly expended. The lieutenants, who command the different batteries, traverse the deck to see that the battle is prosecuted with vivacity; and to exhort and animate the men to their duty. The midshipmen second these injunctions, and give the necessary assistance wherever it may be required, at the guns committed to their charge. The gunner should be particularly attentive that all the artillery is sufficiently supplied with powder, and that the cartridges are carefully conveyed along the decks in covered boxes. The havoc produced by a continuation of this mutual assault may be readily conjectured by the reader's imagination: battering, penetrating, and splintering the sides and decks; shattering or dismounting the cannon; mangling and destroying the rigging; cutting afunder or carrying away the masts and yards; piercing and tearing the sails so as to render them useless; and wounding, disabling, or killing the ship's company! The comparative vigour and resolution of the assailants to effect these pernicious consequences in each other, generally determine their success or defeat: we say generally, because the fate of the combat may sometimes be decided by an unforeseen incident, equally fortunate for the one and fatal to the other. The defeated ship having acknowledged

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the victory, by striking her colours, is immediately taken possession of by the conqueror, who secures her officers and crew as prisoners in his own ship; and invests his principal officer with the command of the prize until a captain is appointed by the commander in chief.

3. The engagement being concluded, they begin to repair: the cannon are secured by their breechings and tackles, with all convenient expedition. Whatever fails have been rendered unserviceable are unbent; and the wounded masts and yards struck upon deck, and fished, or replaced by others. The standing rigging is knotted, and the running-rigging spliced wherever necessary. Proper sails are bent in the room of those which have been displaced as useless. The carpenter and his crew are employed in repairing the breaches made in the ship's hull, by shot-plugs, pieces of plank, and sheet-lead. The gunner and his assistants are busied in replenishing the allotted number of charged cartridges, to supply the place of those which have been expended, and in refitting whatever furniture of the cannon may have been damaged by the late action.

Such is the usual process and consequences of an engagement between two ships of war, which may be considered as an epitome of a general battle between fleets or squadrons. The latter, however, involves a greater variety of incidents, and necessarily requires more comprehensive skill and judgment in the commanding officer.

I. When the admiral, or commander in chief, of a naval armament has discovered an enemy's fleet, his principal concern is usually to approach it, and endeavour to come to action as soon as possible. Every inferior consideration must be sacrificed to this important object; and every rule of action should tend to hasten and prepare for so material an event. The state of the wind, and the situation of his adversary, will in some measure dictate the conduct necessary to be pursued with regard to the disposition of his ships on this occasion. To facilitate the execution of the admiral's orders, the whole fleet is ranged into three squadrons, each of which is classed into three divisions, under the command of different officers. Before the action begins, the adverse fleets are drawn up in two lines, as above described. As soon as the admiral displays the signal for the line of battle, the several divisions separate from the columns, in which they were disposed in the usual order of sailing, and every ship crowds into its station in the wake of the next a-head; and a proper distance from each other, which is generally about 50 fathoms, is regularly observed from the van to the rear. The admiral, however, will occasionally contract or extend his line, so as to conform to the length of that of his adversary, whose neglect or inferior skill on this occasion he will naturally convert to his own advantage, as well as to prevent his own line from being doubled, a circumstance which might throw his van and rear into confusion.

When the adverse fleets approach each other, the courses are commonly hauled up in the brails, and the top-gallant sails and stay-sails furled. The movement of each ship is chiefly regulated by the main and fore-top sails, and the jib; the mizen-top sail being refer-

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ved to hasten or retard the course of the ship, and, in fine, by filling or backing, hoisting or lowering it, to determine her velocity.

The frigates, tenders, and fire-ships, being also hauled upon a wind, lie at some distance, ready to execute the admiral's orders or those of his seconds, leaving the line of battle between them and the enemy. If there are any transports and storeships attendant on the fleet, these are disposed still further distant from the action. If the fleet is superior in number to that of the enemy, the admiral usually selects a body of reserve from the different squadrons, which will always be of use to cover the fire-ships, bomb-vessels, &c. and may fall into the line in any case of necessity; these also are stationed at a convenient distance from the line, and should evidently be opposite to the weakest parts thereof.

And here it may not be improper to observe, with an ingenious French author (M. de Morogues), that order and discipline give additional strength and activity to a fleet. If thus a double advantage is acquired by every fleet, it is certainly more favourable to the inferior, which may thereby change its disposition with greater facility and dispatch than one more numerous, yet without being separated. When courage is equal to both, good order is then the only resource of the smaller number. Hence we may infer, that a smaller squadron of men of war, whose officers are perfectly disciplined in working their ships, may, by its superior dexterity, vanquish a more powerful one, even at the commencement of the fight; because the latter, being less expert in the order of battle, will, by its separation, suffer many of the ships to remain useless, or not sufficiently near, to protect each other.

The signal for a general engagement is usually displayed when the opposite fleets are sufficiently within the range of point-blank shot, so that they may level the artillery with certainty of execution, which is near enough for a line of battle. The action is begun and carried on throughout the fleet in the manner we have already described between single ships; at which time the admiral carries little sail, observing, however, to regulate his own motions by those of the enemy. The ships of the line meanwhile keep close in their stations, none of which should hesitate to advance in their order, although interrupted by the situation of some ship ahead, which has negligently fallen a-fern of her station.

The various exigencies of the combat call forth the skill and resources of the admiral, to keep his line as complete as possible when it has been unequally attacked; by ordering ships from those in reserve to supply the place of others which have suffered greatly by the action; by directing his fire-ships at a convenient time to fall aboard the enemy; by detaching ships from one part of the line or wing which is stronger, to another which is greatly pressed by superior force, and requires assistance. His vigilance is ever necessary to review the situation of the enemy from van to rear; every motion of whom he should, if possible, anticipate and frustrate. He should seize the favourable moments of occasion, which are rapid in their progress, and never return. Far from being disconcerted by any unforeseen incident, he should endeavour, if possible, to make it subservient to his de-

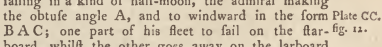
sign. His experience and reflection will naturally furnish him with every method of intelligence to discover the state of his different squadrons and divisions. Signals of inquiry and answers, of request and assent, of command and obedience, will be displayed and repeated on this occasion. Tenders and boats will also continually be detached between the admiral and the commanders of the several squadrons or divisions.

As the danger presses on him, he ought to be fortified by resolution and presence of mind; because the whole fleet is committed to his charge, and the conduct of his officers may, in a great degree, be influenced by his intrepidity and perseverance. In short, his renown or infamy may depend on the fate of the day.

If he conquers in battle, he ought to prosecute his victory as much as possible, by seizing, burning, or destroying the enemy's ships. If he is defeated, he should endeavour, by every resource his experience can suggest, to save as many of his fleet as possible, by employing his tenders, &c. to take out the wounded and put fresh men in their places; by towing the disabled ships to a competent distance; and by preventing the execution of the enemy's fire-ships.

By what we have observed, the real force or superiority of a fleet consists less in the number of vessels, and the vivacity of the action, than in good order, dexterity in working the ships, presence of mind, and skilful conduct in the captains.

#### CHAP. VIII. *Of Retreat and Chace.*

I. WHEN a fleet is obliged to retreat in sight of an enemy, the best way to effect it securely will be by failing in a kind of half-moon, the admiral making the obtuse angle A, and to windward in the form  Plate CC. B A C; one part of his fleet to fail on the star-board, whilst the other goes away on the larboard tack: keeping the fire-ships, transports, &c. in the middle.

This manner of ranging a fleet seems the most advisable, because the enemy can never approach those that endeavour to escape, without exposing themselves at the same time to the fire of the ships to windward: thus the enemy's ships D can never approach the ships E without exposing themselves at the same time to the fire of the admiral A, as likewise to that of his seconds. If the admiral thinks this form gives too great an extent to his fleet, he may easily close his wings or quarters, and make the half-moon more complete; in the midst of which he may place his convoy in safety.

EXAMPLE. This order of retreat was exactly followed by the Dutch admiral Van Tromp, in his engagement with the English off Portland, in the year 1653. The English fleet consisted of 70 sail, under the command of admiral Blake; and the Dutch were as strong, convoying about 200 rich merchant-ships. The two fleets met off Portland, where the English used their utmost efforts to bring on an action. The Dutch had the advantage of the wind, and endeavoured to avoid an engagement to preserve their convoy; but Van Tromp, considering rightly, that if the wind should happen to change, he must be under the necessity of fighting with less advantage, determined upon bearing down to the enemy, making his signal

Retreat and  
Chace.

at the same time for the convoy to keep to windward: he then divided his fleet into three squadrons, and attacked the enemy with great bravery: they received him with equal resolution; which made the action very desperate on both sides, several ships being disabled, sunk, burnt, or destroyed; and nothing but the darkness of the approaching night could separate two such obdurate enemies: during which, each prepared to renew the action, that still remained undecided, with greater fury the next day. Van Tromp found himself much embarrassed how to act; but, after many deliberations, he resolved at last upon that of a retreat: he therefore drew up his fleet into an half-moon, placing his convoy in the middle; that is to say, his own ship to windward formed the obtuse angle of the half-moon, the rest ranging themselves on two lines upon a wind on the same tack, in order to form the faces of the half-moon to cover their convoy. He then made what sail he could, and went away large, firing to the right and left of him at all those that attempted to insult his wings or quarters; and would have entirely saved his convoy, if some of his ships had not badly deserted him. The English ships immediately took the advantage of the intervals these ships left in the face of their floating half-moon, and carried off several of their merchant-ships; which obliged admiral Tromp to replace himself in the line of battle as before, and continue the engagement till night should give him an opportunity of resuming his order of retreat. He was chased the next day by the enemy; but, after sustaining a few broadsides, he got safe into harbour, having acquired by his great valour and skill a rich convoy to his country, that nar-

rowly escaped falling a prey to the enemy.

The most natural course in this form of sailing is to steer away before the wind: but, if necessary, the ships may bear away large upon either tack, or even may keep close upon a wind.

In flying, or retreating, the uncertainty of the weather is to be considered: it may become calm, or the wind may shift favourably. The admiral's schemes may be assisted by the approach of night, or the proximity of the land; since he ought rather to run the ships ashore, if practicable, than suffer them to be taken afloat, and thereby transfer additional strength to the enemy. In short, nothing should be neglected that may contribute to the preservation of his fleet, or prevent any part of it from falling into the hands of the conqueror.

II. When you chase a fleet that endeavours to escape, you detach your best cruisers after them, in order to pick up the stragglers, or force them to action; the body of the victorious fleet should keep the same order or line with the enemy, as nigh as possible, to be ready for action, if necessary. This is only to be understood when the fleet that is chased may not be inferior to the other but that it may hazard an action; for if the one bears no proportion to the other, they must bear down upon them in the same manner as a conquering army ashore carries all before it when it has forced an enemy's camp: otherwise, were the conquerors to wait to draw up in form, the enemy would undoubtedly take the advantage of such an opportunity to make their escape.

## N A V

Navarre,  
Nauade.

NAVARRÉ, a province of Spain, part of the ancient kingdom of Navarre, erected soon after the invasion of the Moors; and is otherwise called *Upper Navarre*, to distinguish it from Lower Navarre, belonging to the French. It is bounded on the south and east by Arragon, on the north by the Pyrenees, and on the west by Old Castile and Biscay; extending from south to north about 80 miles, and from east to west about 75. It abounds in sheep and cattle; game of all kinds, as boars, stags, and roebucks; and in wild-fowl, horses, and honey; yielding also some grain, wine, oil, and a variety of minerals, medicinal waters, and hot baths. Some of the ancient chiefs of this country were called *Sobrarbores*, from the custom, as it is supposed, which prevailed among some of those free nations of choosing and swearing their princes under some particular tree. The name of the province is supposed to be a contraction of *Nava Errea*, signifying, in the language of the Vascones, its ancient inhabitants, "a land of valleys."—For the particulars of its history, see the article SPAIN.

NAUDE (Gabriel), a critic and physician in the 17th century, was born at Paris; and became librarian to the cardinals Bagni and Antonio Barberini at Rome, and afterwards to cardinal Mazarin, who made

## N A V

him canon of Verdun and prior of Lartige in Limosin. Christina queen of Sweden at length invited him into her dominions, and bestowed many marks of her favour and esteem upon him. He returned from thence, and died at Abbeville in 1653. His principal works are, 1. *Syntagma de studio liberali*. 2. *Syntagma de studio militari*. 3. An apology for the great men who have been accused of magic. 4. Instructions concerning the chimerical society of the Rosicrucians. 5. Advice on collecting a library. 6. An appendix to the life of Lewis XI. 7. The science of princes, or political considerations on the body of a state, &c. Naude's works abound with many curious and interesting particulars.

NAVE, in architecture, the body of a church, where the people are disposed, reaching from the baluster, or rail of the door, to the chief choir. Some derive the word from the Greek  $\nu\alpha\upsilon\sigma$ , "a temple;" and others from  $\nu\alpha\upsilon\varsigma$ , "a ship," by reason the vault or roof of a church bears some resemblance to a ship.

NAVEL, in anatomy, the centre of the lower part of the abdomen; being that part where the umbilical vessels passed out of the placenta of the mother. See ANATOMY, p. 366. note (c).

NAVEL-*Wort*, in botany. See COTYLEDON.

NAVEW, in botany. See BRASSICA.

Nave  
Navew.



## N A V I G A T I O N.

NAVIGATION, is the art of conducting or carrying a ship from one port to another.

## H I S T O R Y.

THE poets refer the invention of the art of navigation to Neptune, some to Bacchus, others to Hercules, others to Jason, and others to Janus, who is said to have made the first ship. Historians ascribe it to the Æginetes, the Phœnicians, Tyrians, and the ancient inhabitants of Britain. Some will have it, the first hint was taken from the flight of the kite; others, as Oppian, (*De piscibus*, lib. i.) from the fish called *nautilus*; others ascribe it to accident.—Scripture refers the origin of so useful an invention to God himself, who gave the first specimen thereof in the ark built by Noah under his direction. For the rallery the good man underwent on account of his enterprise shews evidently enough the world was then ignorant of any thing like navigation, and that they even thought it impossible.

However, history represents the Phœnicians, especially those of their capital Tyre, as the first navigators; being urged to seek a foreign commerce by the narrowness and poverty of a slip of ground they possessed along the coasts; as well as by the conveniency of two or three good ports, and by their natural genius to traffic. Accordingly, Lebanon, and the other neighbouring mountains, furnishing them with excellent wood for ship-building, in a short time they were masters of a numerous fleet, which constantly hazarding new navigations, and settling new trades, they soon arrived at an incredible pitch of opulency and populousness; inasmuch as to be in a condition to send out colonies, the principal of which was that of Carthage; which, keeping up their Phœnician spirit of commerce, in time not only equalled Tyre itself, but vastly surpassed it; sending its merchant-fleets through Hercules's pillars, now the straits of Gibraltar, along the western coasts of Africa and Europe; and even, if we believe some authors, to America itself.

Tyre, whose immense riches and power are represented in such lofty terms both in sacred and profane authors, being destroyed by Alexander the Great, its navigation and commerce were transferred by the conqueror to Alexandria, a new city, admirably situated for those purposes; proposed for the capital of the empire of Asia, which Alexander then meditated. And thus arose the navigation of the Egyptians; which was afterwards so cultivated by the Ptolemies, that Tyre and Carthage were quite forgot.

Egypt being reduced into a Roman province after the battle of Actium, its trade and navigation fell into the hands of Augustus; in whose time Alexandria was only inferior to Rome; and the magazines of the capital of the world, were wholly supplied with merchandizes from the capital of Egypt.

At length, Alexandria itself underwent the fate of Tyre and Carthage; being surprised by the Saracens, who, in spite of the emperor Heraclius, overspread

the northern coasts of Africa, &c. whence the merchants being driven, Alexandria has ever since been in a languishing state, though still it has a considerable part of the commerce of the Christian merchants trading to the Levant.

The fall of Rome and its empire drew along with it not only that of learning and the polite arts, but that of navigation; the barbarians, into whose hands it fell, contenting themselves with the spoils of the industry of their predecessors.

But no sooner were the more brave among those nations well settled in their new provinces; some in Gaul, as the Franks; others in Spain, as the Goths; and others in Italy, as the Lombards; but they began to learn the advantages of navigation and commerce, and the methods of managing them, from the people they subdued; and this with so much success, that in a little time some of them became able to give new lessons, and set on foot new institutions for its advantage. Thus it is to the Lombards we usually ascribe the invention and use of banks, book-keeping, exchanges, rechanges, &c.

It does not appear which of the European people, after the settlement of their new masters, first betook themselves to navigation and commerce.—Some think it began with the French; though the Italians seem to have the justest title to it, and are accordingly ordinarily looked on as the restorers hereof, as well as of the polite arts, which had been banished together from the time the empire was torn asunder. It is the people of Italy then, and particularly those of Venice and Genoa, who have the glory of this restoration; and it is to their advantageous situation for navigation they in great measure owe their glory. In the bottom of the Adriatic were a great number of marshy islands, only separated by narrow channels, but those well screened, and almost inaccessible, the residence of some fishermen, who here supported themselves by a little trade of fish and salt, which they found in some of these islands. Thither the Veneti, a people inhabiting that part of Italy along the coasts of the gulph, retired, when Alaric king of the Goths, and afterwards Attila king of the Huns, ravaged Italy.

These new islanders, little imagining that this was to be their fixed residence, did not think of composing any body politic; but each of the 72 islands of this little Archipelago continued a long time under its several masters, and each made a distinct commonwealth. When their commerce was become considerable enough to give jealousy to their neighbours, they began to think of uniting into a body. And it was this union, first begun in the sixth century, but not completed till the eighth, that laid the sure foundation of the future grandeur of the state of Venice. From the time of this union, their fleets of merchantmen were sent to all the parts of the Mediterranean; and at last to those of Egypt, particularly Cairo, a new city, built by the Saracen princes on the eastern banks of the Nile, where they traded for their spices and other products of the Indies. Thus they flourished, increased their

commerce

commerce, their navigation, and their conquests on the terra firma, till the league of Cambray in 1508, when a number of jealous princes conspired to their ruin; which was the more easily effected by the diminution of their East-India commerce, of which the Portuguese had got one part, and the French another. Genoa, which had applied itself to navigation at the same time with Venice, and that with equal success, was a long time its dangerous rival, disputed with it the empire of the sea, and shared with it the trade of Egypt and other parts both of the east and west.

Jealousy soon began to break out; and the two republics coming to blows, there was almost continual war for three centuries ere the superiority was ascertained; when, towards the end of the 14th century, the battle of Chioza ended the strife: the Genoese, who till then had usually the advantage, having now lost all; and the Venetians, almost become desperate, at one happy blow, beyond all expectation, secured to themselves the empire of the sea, and superiority in commerce.

About the same time that navigation was retrieved in the southern parts of Europe, a new society of merchants was formed in the north, which not only carried commerce to the greatest perfection it was capable of till the discovery of the East and West Indies, but also formed a new scheme of laws for the regulation thereof, which still obtain under the names of *Uses and Customs of the Sea*. This society is that famous league of the Hanse-towns, commonly supposed to have begun about the year 1164. See *HANSE Towns*.

For the modern state of navigation in England, Holland, France, Spain, Portugal, &c. See *COMMERCE, COMPANY, &c.*

We shall only add, that, in examining the reasons of commerce's passing successively from the Venetians, Genoese, and Hanse-towns, to the Portuguese and Spaniards, and from these again to the English and Dutch; it may be established as a maxim, that the relation between commerce and navigation, or, if we may be allowed to say it, their union is so intimate, that the fall of the one inevitably draws after it the other; and that they will always either flourish or dwindle together. Hence so many laws, ordinances, statutes, &c. for its regulation; and hence particularly that celebrated act of navigation, which an eminent foreign author calls the *palladium or tutelar deity of the commerce of England*; which is the standing rule, not only of the British among themselves, but also of other nations with whom they traffic.

The art of navigation hath been exceedingly improved in modern times, both with regard to the form of the vessels themselves, and with regard to the methods of working them. The use of rowers is now entirely superseded by the improvements made in the formation of the sails, rigging, &c. by which means the ships can not only sail much faster than formerly, but can tack in any direction with the greatest facility. It is also very probable that the ancients were neither so well skilled in finding the latitudes, nor in steering their vessels in places of difficult navigation, as the moderns. But the greatest advantage which the mo-

derns have over the ancients is from the mariner's compass, by which they are enabled to find their way with as great facility in the midst of an immeasurable ocean, as the ancients could have done by creeping along the coast, and never going out of sight of land. Some people indeed contend, that this is no new invention, but that the ancients were acquainted with it. They say, that it was impossible for Solomon to have sent ships to Ophir, Tarshish, and Parvaim, which last they will have to be *Peru*, without this useful instrument. They insist, that it was impossible for the ancients to be acquainted with the attractive virtue of the magnet, and to be ignorant of its polarity. Nay, they affirm, that this property of the magnet is plainly mentioned in the book of Job, where the loadstone is mentioned by the name of *1opaz*, or *the stone that turns itself*. But it is certain, that the Romans, who conquered Judaea, were ignorant of this instrument; and it is very improbable, that such an useful invention, if once it had been commonly known to any nation, would have been forgot, or perfectly concealed from such a prudent people as the Romans, who were so much interested in the discovery of it.

Among those who do agree that the mariner's compass is a modern invention, it hath been much disputed who was the inventor. Some give the honour of it to Flavio Gioia of Amalfi in Campania\*, who lived about the beginning of the 14th century; while others say that it came from the east, and was earlier known in Europe. But, at whatever time it was invented, it is certain, that the mariner's compass was not commonly used in navigation before the year 1420. In that year the science was considerably improved under the auspices of Henry duke of Visco, brother to the king of Portugal. In the year 1485, Roderic and Joseph, physicians to king John II. of Portugal, together with one Martin de Bohemia, a Portuguese native of the island of Fayal, and scholar to Regiomontanus, calculated tables of the sun's declination for the use of sailors, and recommended the astrolabe for taking observations at sea. Of the instructions of Martin, the celebrated Christoph Columbus is said to have availed himself, and to have improved the Spaniards in the knowledge of the art; for the farther progress of which a lecture was afterwards founded at Seville by the emperor Charles V.

The discovery of the variation is claimed by Columbus, and by Sebastian Cabot. The former certainly did observe this variation without having heard of it from any other person, on the 14th of September 1492, and it is very probable that Cabot might do the same. At that time it was found that there was no variation at the Azores, where some geographers have thought proper to place the first meridian; though it hath since been observed that the variation alters in time.—The use of the cross-staff now began to be introduced among sailors. This ancient instrument is described by John Werner of Nuremberg, in his annotations on the first book of Ptolemy's Geography, printed in 1514. He recommends it for observing the distance between the moon and some star, in order thence to determine the longitude.

At this time the art of navigation was very imperfect on account of the inaccuracies of the plane chart, which

\* See *Mariner's Compass*.

which was the only one then known, and which, by its gross errors, must have greatly misled the mariner, especially in voyages far distant from the equator. Its precepts were probably at first only set down on the sea-charts, as is the custom at this day: but at length there were two Spanish treatises published in 1545; one by Pedro de Medina; the other by Martin Cortis, which contained a complete system of the art, as far as it was then known. These seem to have been the oldest writers who fully handled the art; for Medina, in his dedication to Philip prince of Spain, laments that multitudes of ships daily perished at sea, because there were neither teachers of the art, nor books by which it might be learned; and Cortes, in his dedication, boasts to the emperor, that he was the first who had reduced navigation into a compendium, valuing himself much on what he had performed. Medina defended the plane chart; but he was opposed by Cortes, who shewed its errors, and endeavoured to account for the variation of the compass, by supposing the needle to be influenced by a magnetic pole (which he called the *point attractive*) different from that of the world: which notion hath been farther prosecuted by others. Medina's book was soon translated into Italian, French, and Flemish, and served for a long time as a guide to foreign navigators. However Cortes was the favourite author of the English nation, and was translated in 1561; while Medina's work was entirely neglected, though translated also within a short time of the other. At that time the system of navigation consisted of the following particulars, and others similar: An account of the Ptolemaic hypothesis, and the circles of the sphere; of the roundness of the earth, the longitudes, latitudes, climates, &c. and eclipses of the luminaries; a calendar; the method of finding the prime, epoch, moon's age, and tides; a description of the compass, an account of its variation, for the discovering of which Cortes said an instrument might easily be contrived; tables of the sun's declination for four years, in order to find the latitude from his meridian altitude; directions to find the same by certain stars: of the course of the sun and moon; the length of the days; of time and its divisions; the method of finding the hour of the day and night; and lastly, a description of the sea-chart, on which to discover where the ship is, they made use of a small table, that shewed, upon an alteration of one degree of the latitude, how many leagues were run in each rhumb, together with the departure from the meridian. Besides, some instruments were described, especially by Cortes; such as one to find the place and declination of the sun, with the days, and place of the moon; certain dials, the astrolabe, and cross-staff; with a complex machine to discover the hour and latitude at once.

About the same time were made proposals for finding the longitude by observations on the moon. In 1530, Gemma Frisius advised the keeping of the time by means of small clocks or watches, then, as he says, newly invented. He also contrived a new sort of cross-staff and an instrument called the *nautical quadrant*; which last was much praised by William Cuninghame, in his *Astronomical Glass*, printed in the year 1559.

In 1537 Pedro Nunez, or Nonius, published a book

in the Portuguese language, to explain a difficulty in navigation proposed to him by the commander Don Martin Alphonso de Sufa. In this he exposes the errors of the plane chart, and likewise gives the solution of several curious astronomical problems; amongst which is that of determining the latitude from two observations of the sun's altitude and intermediate azimuth being given. He observed, that though the rhumbs are spiral lines, yet the direct course of a ship will always be in the arch of a great circle, whereby the angle with the meridians will continually change: all that the steersman can here do for the preserving of the original rhumb, is to correct these deviations as soon as they appear sensible. But thus the ship will in reality describe a course without the rhumb line intended; and therefore his calculations for assigning the latitude, where any rhumb-line crosses the several meridians, will be in some measure erroneous. He invented a method of dividing a quadrant by means of concentric circles, which, after being much improved by Dr Halley, is used at present, and is called a *nonius*.

In 1577, Mr William Bourne published a treatise, in which, by considering the irregularities in the moon's motion, he shews the errors of the sailors in finding her age by the epoch, and also in determining the hour from observing on what point of the compass the sun and moon appeared. He advises, in sailing towards the high latitudes, to keep the reckoning by the globe, as there the plane chart is most erroneous. He despairs of our ever being able to find the longitude, unless the variation of the compass should be occasioned by some such attractive point, as Cortes had imagined; of which, however, he doubts: but as he had shewn how to find the variation at all times, he advises to keep an account of the observations, as useful for finding the place of the ship; which advice was prosecuted at large by Simon Stevin in a treatise published at Leyden in 1599; the subject of which was the same year printed at London in English by Mr Edward Wright, intitled the *Haven-finding Art*. In this ancient tract also is described the way by which our sailors estimate the rate of a ship in her course, by an instrument called the *log*. This was so named from the piece of wood or log that floats in the water while the time is reckoned during which the line that is fastened to it is veering out. The author of this contrivance is not known; neither was it taken notice of till 1607, in an East-India voyage published by Purchas: but from this time it became famous, and was much taken notice of by almost all writers on navigation in every country; and it still continues to be used as at first, though many attempts have been made to improve it, and contrivances proposed to supply its place; many of which have succeeded in quiet water, but proved useless in a stormy sea.

In 1581 Michael Coignet, a native of Antwerp, published a treatise in which he animadverted on Medina. In this he shewed, that as the rhumbs are spirals, making endless revolutions about the poles, numerous errors must arise from their being represented by straight lines on the sea-charts; but though he hoped to find a remedy for these errors, he was of opinion that the proposals of Nonius were scarcely practicable, and therefore in a great measure useless. In treating

treating of the sun's declination, he took notice of the gradual decrease in the obliquity of the ecliptic; he also described the cross-staff with three transverse pieces, as it is at present made, and which he owed to have been then in common use among the sailors. He likewise gave some instruments of his own invention; but all of them are now laid aside, excepting perhaps his nocturnal. He constructed a sea-table to be used by such as sailed beyond the 60th degree of latitude; and at the end of the book is delivered a method of sailing on a parallel of latitude by means of a ring dial and a 24 hour-glass. The same year the discovery of the dipping needle was made by Mr Robert Forman<sup>o</sup>. In his publication on that art he maintains, in opposition to Cortes, that the variation of the compass was caused by some point on the surface of the earth, and not in the heavens: he also made considerable improvements in the construction of compasses themselves; shewing especially the danger of not fixing, on account of the variation, the wire directly under the *flower-de-luce*; as compasses made in different countries have placed it differently. To this performance of Forman's is always prefixed a discourse on the variation of the magnetic needle, by Mr William Burrough, in which he shews how to determine the variation in many different ways. He also points out many errors in the practice of navigation at that time, and speaks in very severe terms concerning those who had published upon it. All this time the Spaniards had continued to publish treatises on the art. In 1585 an excellent compendium was published by Roderico Zamorano; which contributed greatly towards the improvement of the art, particularly in the sea-charts. Globes of an improved kind, and of a much larger size than those formerly used, were now constructed, and many improvements were made in other instruments; however, the plane chart continued still to be followed, though its errors were frequently complained of. Methods of removing these errors had indeed been sought after; and Gerard Mercator seems to have been the first who found the true method of doing this so as to answer the purposes of seamen. His method was to represent the parallels both of latitude and longitude by parallel straight lines, but gradually to augment the former as they approached the pole. Thus the rhumbs, which otherwise ought to have been curves, were now also extended into straight lines; and thus a straight line drawn between any two places marked upon the chart would make an angle with the meridians, expressing the rhumb leading from the one to the other. But though, in 1569, Mercator published an universal map constructed in this manner, it doth not appear that he was acquainted with the principles on which this proceeded; and it is now generally believed, that the true principles on which the construction of what is called *Mercator's chart* depends, were first discovered by an Englishman, Mr Edward Wright.

Mr Wright supposes, but, according to the general opinion, without sufficient grounds, that this enlargement of the degrees of latitude was known and mentioned by Ptolemy, and that the same thing had also been spoken of by Cortes. The expressions of Ptolemy alluded to, relate indeed to the proportion between the distances of the parallels and meridians; but instead of proposing any gradual enlargement of the

parallels of latitude, in a general chart, he speaks only of particular maps; and advises not to confine a system of such maps to one and the same scale, but to plan them out by a different measure, as occasion might require: only with this precaution, that the degrees of longitude in each should bear some proportion to those of latitude; and this proportion is to be deduced from that which the magnitude of the respective parallels bear to a great circle of the sphere. He adds, that in particular maps, if this proportion be observed with regard to the middle parallel, the inconvenience will not be great tho' the meridians should be straight parallels to each other. Here he is said only to mean, that the maps should in some measure represent the figures of the countries for which they are drawn. In this sense Mercator, who drew maps for Ptolemy's tables, understood him: thinking it, however, an improvement not to regulate the meridians by one parallel, but by two; one distant from the northern, the other from the southern extremity of the map by a fourth part of the whole depth; by which means, in his maps, though the meridians are straight lines, yet they are generally drawn inclining to each other towards the poles. With regard to Cortes, he speaks only of the number of degrees of latitude, and not of the extent of them; nay, he gives express directions that they should all be laid down by equal measurement on a scale of leagues adapted to the map.

For some time after the appearance of Mercator's map, it was not rightly understood, and it was even thought to be entirely useless, if not detrimental. However, about the year 1592, its utility began to be perceived; and seven years after, Mr Wright printed his famous treatise entitled, *The Correction of certain Errors in Navigation*; where he fully explained the reason of extending the length of the parallels of latitude, and the uses of it to navigators. In 1610, a second edition of Mr Wright's book was published with improvements. An excellent method was proposed of determining the magnitude of the earth; at the same time it was judiciously proposed to make our common measures in some proportion to a degree on its surface, that they might not depend on the uncertain length of a barley-corn. Some of his other improvements were, "The table of latitudes for dividing the meridian computed to minutes;" whereas it had only been divided to every tenth minute. He also published a description of an instrument which he calls the *sea-ring*; and by which the variation of the compass, altitude of the sun, and time of the day, may be determined readily at once in any place, provided the latitude is known. He shewed also how to correct the errors arising from the excentricity of the eye in observing by the cross-staff. He made a total amendment in the tables of the declinations and places of the sun and stars from his own observations made with a six-foot quadrant in the years 1594, 95, 96, and 97. A sea-quadrant to take altitudes by a forward or backward observation; and likewise with a contrivance for the ready finding the latitude by the height of the pole-star, when not upon the meridian. To this edition was subjoined a translation of Zamorano's Compendium above-mentioned; in which he corrected some mistakes in the original; adding a large table of the variation of the compass observed in very different parts

parts of the world, to shew that it was not occasioned by any magnetical pole.

These improvements soon became known abroad. In 1608, a treatise intitled, *Hypomenata Mathematica*, were published by Simon Stevin, for the use of Prince Maurice. In that part relating to navigation, the author having treated of sailing on a great circle, and shewn how to draw the rhumbs on a globe mechanically, sets down Wright's two tables of latitude and of rhumbs, in order to describe these lines more accurately, pretending even to have discovered an error in Wright's table. But all Stevin's objections were fully answered by the author himself, who showed that they arose from the gross way of calculating made use of by the former.

In 1624, the learned Wellebrordus Snellius, professor of mathematics at Leyden, published a treatise of navigation on Wright's plan, but somewhat obscurely; and as he did not particularly mention all the discoveries of Wright, the latter was thought by some to have taken the hint of all his discoveries from Snellius. But this supposition is long ago refuted; and Wright enjoys the honour of those discoveries which is justly his due.

Mr Wright having shown how to find the place of the ship on his chart, observed that the same might be performed more accurately by calculation: but considering, as he says, that the latitudes, and especially the courses at sea, could not be determined so precisely, he forbore setting down particular examples; as the mariner may be allowed to save himself this trouble, and only mark out upon his chart the ship's way after the manner then usually practised. However, in 1614, Mr Raphie Handfon, among his nautical questions subjoined to a translation of Pitiscus's trigonometry, solved very distinctly every case of navigation, by applying arithmetical calculations to Wright's table of latitudes, or of meridional parts, as it hath since been called. Though the method discovered by Wright for finding the change of longitude by a ship sailing on a rhumb is the proper way of performing it, Handfon also proposes two ways of approximation to it without the assistance of Wright's division of the meridian line. The first was computed by the arithmetical mean between the co-sines of both latitudes; the other by the same mean between the secants as an alternative, when Wright's book was not at hand; tho' this latter is wider from the truth than the first. By the same calculations also he showed how much each of these compendiums deviates from the truth, and also how widely the computations on the erroneous principles of the plane chart differ from them all. The method, however, commonly used by our sailors is commonly called the *middle latitude*; which, though it errs more than that by the arithmetical mean between the two co-sines, is preferred on account of its being less perverse: yet in high latitudes it is more eligible to use that of the arithmetical mean between the logarithmic co-sines, equivalent to the geometrical mean between the co-sines themselves; a method since proposed by Mr John Bassat. The computation by the middle latitude will always fall short of the true change of longitude; that by the geometrical mean will always exceed; but that by the arithmetical mean falls short in latitudes above 45 degrees, and exceeds in less

fer latitudes. However, none of these methods will differ much from the truth when the change of latitude is sufficiently small.

About this time logarithms were invented by John Napier, baron of Merchilton in Scotland, and proved of the utmost service to the art of navigation. They were first applied by Mr Edward Gunter in 1620. He constructed a table of artificial sines and tangents to every minute of the quadrant. These were applied according to Wright's table of meridional parts, and have been found extremely useful in other branches of the mathematics. He contrived also a most excellent ruler, commonly known by the name of *Gunter's scale*, on which were inscribed the logarithmic lines for numbers, and for sines and tangents of arches\*. He also greatly improved the sector for the same purposes. He shewed also how to take a back-observation by the cross-staff, whereby the error arising from the eccentricity of the eye is avoided. He described likewise another instrument of his own invention, called the *cross-bow*, for taking altitudes of the sun or stars, with some contrivances for the more ready collecting the latitude from the observation. The discoveries concerning the logarithms were carried to France in 1624 by Mr Edmund Wingate, who published two small tracts in that year at Paris. In one of these he taught the use of Gunter's scale; and in the other, of the tables of artificial sines and tangents, as modelled according to Napier's last form, erroneously attributed by Wingate to Briggs.

Gunter's ruler was projected into a circular arch by the reverend Mr William Oughtred in 1633, and its uses fully shown in a pamphlet intitled, *The circles of proportion*; where, in an appendix, are well handled several important points in navigation. It has also been made in the form of a sliding ruler.

The logarithmic tables were first applied to the different cases of sailing by Mr Thomas Addison, in his treatise intitled, *Arithmetical navigation*, printed in 1625. He also gives two traverse tables, with their uses; the one to quarter points of the compass, the other to degrees. Mr Henry Gellibrand published his discovery of the changes of the variation of the compass, in a small quarto pamphlet, intitled, *A discourse mathematical on the variation of the magnetical needle*, printed in 1655. This extraordinary phenomenon he found out by comparing the observations made at different times near the same place by Mr Burrough, Mr Gunter, and himself, all persons of great skill and experience in these matters. This discovery was likewise soon known abroad; for Father Athanasius Kircher, in his treatise intitled, *Magnes*, first printed at Rome in 1641, informs us, that he had been told it by Mr John Greaves; and then gives a letter of the famous Marinus Mercennus, containing a very distinct account of the same.

As altitudes of the sun are taken on shipboard by observing his elevation above the visible horizon, to collect from thence the sun's true altitude with correctness, Wright observes it to be necessary that the dip of the horizon below the observer's eye should be brought into the account, which cannot be calculated without knowing the magnitude of the earth. Hence he was induced to propose different methods for finding this; but complains that the most effectual was out

\* See Gunter's Scale.

of his power to execute; and therefore contented himself with a rude attempt, in some measure sufficient for his purpose: and the dimensions of the earth deduced by him corresponded so well with the usual divisions of the log-line, that as he writ not an express treatise on navigation, but only for the correcting such errors as prevailed in general practice, the log-line did not fall under his notice. Mr Richard Norwood, however, put in execution the method recommended by Mr Wright as the most perfect for measuring the dimensions of the earth, with the true length of the degrees of a great circle upon it; and, in 1635, he actually measured the distance between London and York; from whence, and the summer solstitial altitudes of the sun observed on the meridian at both places, he found a degree on a great circle of the earth to contain 367,196 English feet, equal to 57,300 French fathoms or toises: which is very exact, as appears from many measures that have been made since that time. Of all this Mr Norwood gave a full account in his treatise called *The seaman's practice*, published in 1637. He there shows the reason why Snellius had failed in his attempt; he points out also various uses of his discovery, particularly for correcting the gross errors hitherto committed in the divisions of the log-line. These necessary amendments, however, were little attended to by the sailors, whose obliquity in adhering to established errors has been complained of by the best writers on navigation; but at length they found their way into practice, and few navigators of reputation now make use of the old measure of 42 feet to a knot. In that treatise also Mr Norwood describes his own excellent method of setting down and perfecting a sea-reckoning, by using a traverse table; which method he had followed and taught for many years. He shows also how to rectify the course by the variation of the compass being considered; as also how to discover currents, and to make proper allowance on their account. This treatise, and another on trigonometry, were continually reprinted, as the principal books for learning scientifically the art of navigation. What he had delivered, especially in the latter of them, concerning this subject, was contracted as a manual for sailors, in a very small piece called his *Epitome*; which useful performance has gone through a great number of editions. No alterations were ever made in the Seaman's Practice till the 12th edition in 1676, when the following paragraph was inserted in a smaller character: "About the year 1672, Monsieur Picart has published an account in French, concerning the measure of the earth, a breve whereof may be seen in the Philosophical Transactions, n<sup>o</sup> 112; wherein he concludes one degree to contain 365,184 English feet, nearly agreeing with Mr Norwood's experiment;" and this advertisement is continued through the subsequent editions as late as the year 1732. About the year 1645, Mr Bond published in Norwood's epitome a very great improvement in Wright's method by a property in his meridian line, whereby its divisions are more scientifically assigned than the author himself was able to effect; which was from this theorem, that these divisions are analogous to the excesses of the logarithmic tangents of half the respective latitudes augmented by 45 degrees above the logarithm of the radius. This he afterwards explained more fully in

the third edition of Gunter's works, printed in 1653; where, after observing that the logarithmic tangents from 45° upwards increase in the same manner that the secants added together do; if every half degree be accounted as a whole degree of Mercator's meridional line. His rule for computing the meridional parts belonging to any two latitudes, pupposed on the same side of the equator, is to the following effect. "Take the logarithmic tangent, rejecting the radius, of half each latitude, augmented by 54 degrees; divide the difference of those numbers by the logarithmic tangent of 50° 30', the radius being likewise rejected; and the quotient will be the meridional parts required, expressed in degrees." This rule is the immediate consequence from the general theorem, That the degrees of latitude bear to one degree, (or 60 minutes, which in Wright's table stands for the meridional parts of one degree), the same proportion as the logarithmic tangent of half any latitude augmented by 45 degrees, and the radius neglected, to the like tangent of half a degree augmented by 45 degrees, with the radius likewise rejected. But here was farther wanting the demonstration of this general theorem, which was at length supplied by Mr James Gregory of Aberdeen, in his *Exercitationes Geometricæ*, printed at London in 1668; and afterwards more concisely demonstrated, together with a scientific determination of the divisor, by Dr Halley in the Philosophical Transactions for 1695, n<sup>o</sup> 219. from the consideration of the spirals into which the rhumbs are transformed in the stereographic projection of the sphere upon the plane of the equinoctial; and which is rendered still more simple by Mr Roger Cotes, in his Logometria, first published in the Philosophical Transactions for 1714, n<sup>o</sup> 388. It is moreover added in Gunter's book, that if  $\frac{1}{2}$  of this division, which does not sensibly differ from the logarithmic tangent of 45° 1' 30" (with the radius subtracted from it), be used, the quotient will exhibit the meridional parts expressed in leagues: and this is the divisor set down in Norwood's Epitome. After the same manner the meridional parts will be found in minutes, if the like logarithmic tangent of 45° 1' 30", diminished by the radius, be taken; that is, the number used by others being 12633, when the logarithmic tables consist of eight places of figures besides the index. In an edition of the seaman's kalendar, Mr Bond declared, that he had discovered the longitude by having found out the true theory of the magnetic variation; and to gain credit to his assertion, he foretold, that at London, in 1657, there would be no variation of the compass, and from that time it would gradually increase the other way; which happened accordingly. Again, in the Philosophical Transactions for 1668, n<sup>o</sup> 40. he published a table of the variation for 49 years to come. Thus he acquired such reputation, that his treatise, intitled, *The longitude found*, was, in 1676, published by the special command of Charles II. and approved by many celebrated mathematicians. It was not long, however, before it met with opposition; and, in 1678, another treatise, intitled, *The longitude not found*, made its appearance; and as Mr Bond's hypothesis did not in any manner answer its author's sanguine expectations, the affair was undertaken by Dr Halley. The result of his speculations was, that the magnetic needle is influenced

**THEORY.** influenced by four poles; but this wonderful phenomenon seems hitherto to have eluded all our researches. In 1700, however, Dr Halley published a general map, with curve lines expressing the paths where the magnetic needle had the same variation; which was received with universal applause. But as the positions of these curves vary from time to time, they should frequently be corrected by skilful persons; as was done in 1744 and 1756, by Mr William Moun- taine, and Mr James Dodion, F. R. S. In the Philo- sophical Transactions for 1690, Dr Halley also gave a dissertation on the monsoons; containing many very useful observations for such as sail to places subject to these winds.

After the true principles of the art were settled by Wright, Bond, and Norwood, the authors on navigation became so numerous, that it would be im- possible to enumerate them; and every thing rela- tive to it was settled with an accuracy not only un- known to former ages, but which would have been

reckoned utterly impossible. The earth being found to be a spheroid, and not a perfect sphere, with the shortest diameter passing through the poles, a tract was published in 1741 by the Rev. Dr Patrick Mur- doch, wherein he accommodated Wright's sailing to such a figure; and Mr Colin Maclaurin, the same year, in the Philosophical Transactions, n<sup>o</sup> 461, gave a rule for determining the meridional parts of a spheroid; which speculation is farther treated of in his book of Fluxions, printed at Edinburgh in 1742.

Among foreign nations also many treatises were now published; but excepting the remarkable disco- very of the longitude by Mr Harrison, no confi- derable improvement hath been made any-where. In- deed, the subject hath been so much canvassed and studied by men of learning and ingenuity in all na- tions, that there seems to be little room for farther improvements; and the art of navigation seems to be nearly brought to as much perfection as it is ca- pable of.

## PART I. THEORY OF NAVIGATION.

**T**HE motion of a ship in the water is well known to depend on the action of the wind upon its sails, regulated by the direction of the helm. As the water is a resisting medium, and the bulk of the ship very considerable, it thence follows, that there is al- ways a great resistance on her fore-part; and when this resistance becomes sufficient to balance the moving force of the wind upon the sails, the ship attains her utmost degree of velocity, and her motion is no longer accelerated. This velocity is different according to the different strength of the wind: but the stronger the wind, the greater resistance is made to the ship's passage through the water; and hence, though the wind should blow ever so fiercely, there is also a limit to the velocity of the ship: for the sails and ropes can bear but a certain force of air; and when the resistance on the fore-part becomes more than equivalent to their strength, the velocity can be no longer increased, and the tackle gives way.

The direction of a ship's motion depends on the situation of her sails with regard to the wind. The most natural and easy position is, when she runs di- rectly before it; but this is not often the case, on ac- count of the variable nature of the winds, and the situations of the different ports to which the ship may be bound. When the wind therefore happens not to be favourable, the rudder and sails must be managed in such a manner that the ship may make an angle with the direction of the current of air, as represented Plate CCI. fig. 4. Thus, supposing a ship at D, bound for the port B. Supposing DG the length of the keel, it must be kept by the rudder in such a po- sition as to make the acute angle EDB with the di- rection of the wind. If, when she arrives at B, it is required to sail to another port A, the keel must be kept in the position BF; and thus, by continually making the angle EBA with the direction of the wind, she will arrive at the desired port; and in this manner may a ship be steered to any other port, sup- pose to C or H.

The reason of the ship's motion in these cases is,

that the water resists the side more than the fore-part, and that in the same proportion that her length ex- ceeds her breadth. This proportion is so considerable, that the ship continually flies off where the resistance is least, and that sometimes with great swiftness. In this way of sailing, however, there is a great limita- tion: for if the angle made by the keel with the di- rection of the wind be too acute, the ship cannot be kept in that position; neither is it possible for a large ship to make a more acute angle with the wind than  $67\frac{1}{2}$  degrees; though small floops, it is said, may make an angle of 56 or 57 degrees with it. In all these cases, however, the velocity of the ship is greatly retarded; and not only on account of the obliquity of her motion, but by reason of what is called her *lee- way*. This is occasioned by the yielding of the water on the lee-side of the ship, by which means the vessel acquires a compound motion, partly in the direction of the wind, and partly in that which is necessary for attaining the desired haven. Thus, supposing a ship to set out from B, in the direction BA, the force of the wind will have such an impression upon her, that, instead of keeping the straight path BFFF, she will follow that of Babc, &c. and thus will fall short of her intended port by some considerable space, as Af.

It is perhaps impossible to lay down any mathema- tical principles on which the lee-way of a ship could be properly calculated; only we may see in general that it depends on the strength of the wind, the roughness of the sea, and the velocity of the ship. When the wind is not very strong, the resistance of the water on the lee-side bears a very great proportion to that of the current of air; and therefore it will yield but very little: however, supposing the ship to remain in the same place, it is evident, that the water, having once begun to yield will continue to do so for some time, even though no additional force was ap- plied to it; but as the wind continually applies the same force as at first, the lee-way of the ship must go on constantly increasing till the resistance of the water

THEORY.

on the lee side balances the force applied on the other, when it will become uniform, as doth the motion of a ship sailing before the wind. If the ship changes her place with any degree of velocity, then every time she moves her own length, a new quantity of water is to be put in motion, which hath not yet received any momentum, and which of consequence will make a greater resistance than it can do when the ship remains in the same place. In proportion to the swiftness of the ship, then, the lee-way will be the less: but if the wind is very strong, the velocity of the ship bears but a small proportion to that of the current of air; and the same effects must follow as though the ship moved slowly, and the wind was gentle; that is, the ship must make a great deal of lee-way.—The same thing happens when the sea rises high, whether the wind is strong or not; for then the whole water of the ocean, as far as the swell reaches, hath acquired a motion in a certain direction, and that to a very considerable depth. The mountainous waves will not fail to carry the ship very much out of her course; and this deviation will certainly be according to their velocity and magnitude. In all cases of a rough sea, therefore, a great deal of lee-way is made.—Another circumstance also makes a variation in the quantity of the lee-way; namely, the lightness or heaviness of the ship; it being evident, that when the ship sinks deep in the water, a much greater quantity of that element is to be put in motion before she can make any lee-way, than when she swims on the surface. As therefore it is impossible to calculate all these things with mathematical exactness, it is plain that the real course of a ship is exceedingly difficult to be found, and frequent errors must be made, which only can be corrected by celestial observations.

In many places of the ocean there are *currents*, or places where the water, instead of remaining at rest, runs with a very considerable velocity for a great way in some particular direction, and which will certainly carry the ship greatly out of her course. This occasions an error of the same nature with the lee-way; and therefore, whenever a current is perceived, its velocity ought to be determined, and the proper allowances made.

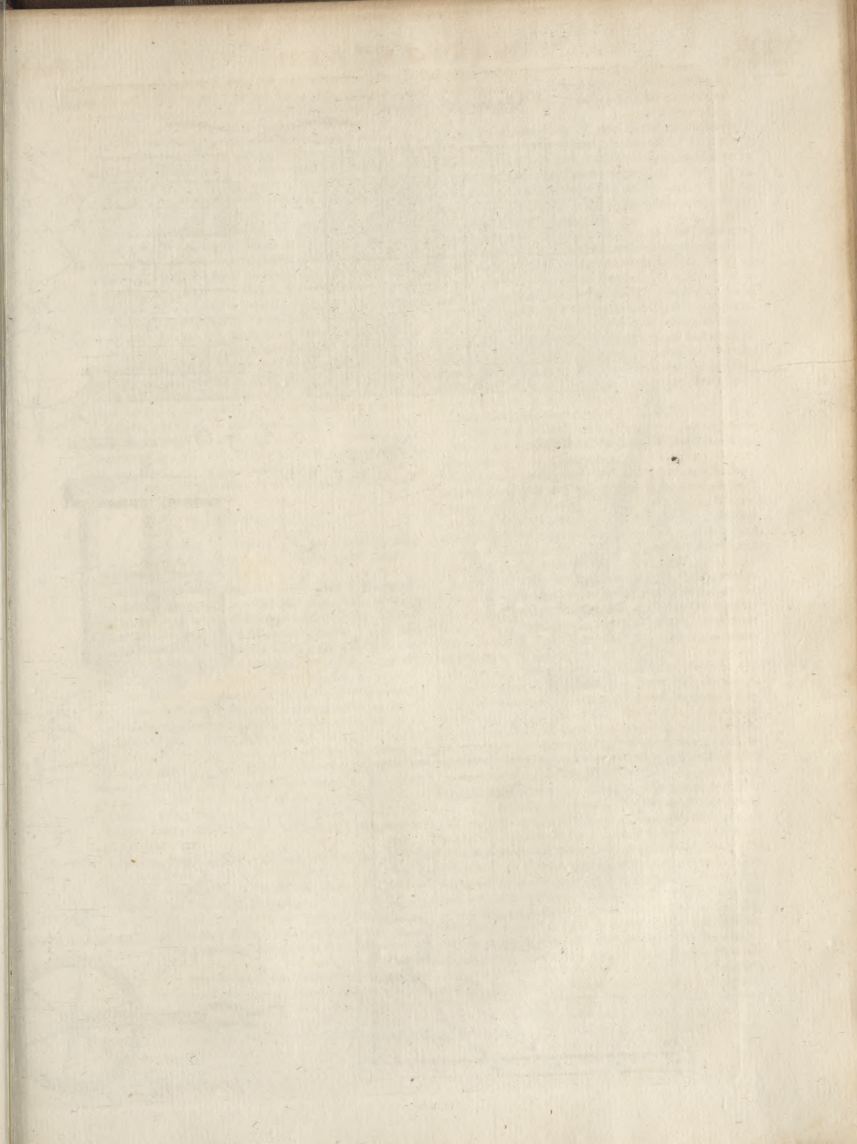
Another source of error in reckoning the course of a ship proceeds from the variation of the compass. There are few parts of the world where the needle points exactly north; and in those where the variation is known, it is subject to very considerable alterations. By these means the course of the ship is mistaken; for as the sailors have no other standard to direct them than the compass, if the needle, instead of pointing due north, should point north-east, a prodigious error would be occasioned during the course of the voyage, and the ship would not come near the port to which she was bound. To avoid errors of this kind the only method is, to observe the azimuths as frequently as possible, by which the difference of variation will be perceived, and the proper allowances can then be made for errors in the course which this may be occasioned.

Errors will arise in the reckoning of a ship, especi-

ally when she sails in high latitudes, from the spheroidal figure of the earth; for as the polar diameter of our globe is found to be considerably shorter than the equatorial one, it thence follows, that the farther we remove from the equator the longer are the degrees of latitude. Of consequence, if a navigator assigns any certain number of miles for the length of a degree of latitude near the equator, he must vary that measure as he approaches towards the poles, otherwise he will imagine that he hath not sailed so far as he actually hath done. It would therefore be necessary to have a table containing the length of a degree of latitude in every different parallel from the equator to either pole; as without this a troublesome calculation must be made at every time the navigator makes a reckoning of his course. Such a table, however, hath not yet appeared; neither indeed seems it to be easy to make it, on account of the difficulty of measuring the length even of one or two degrees of latitude in different parts of the world. Sir Isaac Newton first discovered this spheroidal shape of the earth; and shewed, from experiments on pendulums, that the polar diameter was to the equatorial one as 229 to 230. This proportion, however, hath not been admitted by succeeding calculators. The French mathematicians who measured a degree on the meridian in Lapland, made the proportion between the equatorial and polar diameters to be as 1 to 0.9891. Those who measured a degree at Quito in Peru, made the proportion 1 to 0.99624, or 266 to 265. M. Bouguer makes the proportion to be as 179 to 178; and M. Buffon, in one part of his theory of the earth, makes the equatorial diameter exceed the polar one by  $\frac{1}{27}$  of the whole. From these variations it appears that the point is not exactly determined, and consequently that any corrections which can be made with regard to the spheroidal figure of the earth must be very uncertain.

It is of consequence to navigators in a long voyage to take the nearest way to their port; but this can seldom be done without considerable difficulty. The shortest distance between any two points of a sphere is measured by an arch of a great circle intercepted between them; and therefore, excepting where both places lie under the same parallel of latitude, it is advisable to direct the ship along a great circle of the earth's surface. But this is a matter of considerable difficulty, because there are no fixed marks by which it can be readily known whether the ship sails in the direction of a great circle or not. For this reason the sailors commonly choose to direct their course by the rhumbs, or the bearing of the place by the compass. These bearings do not point out the shortest distance between places; because, on a globe, the rhumbs are spirals, and not arches of great circles. However, when the places lie directly under the equator, or exactly under the same meridian, the rhumb then coincides with the arch of a great circle, and of consequence shews the nearest way. The failing on the arch of a great circle is called *great circle sailing*; and the cases of it depend all on the solution of problems in spheric trigonometry.





# Fig. 1. NEPERS RODS

No. 1.

1	1	2	3	4	5	6	7	8	9	0
2	2	4	6	8	10	12	14	16	18	0
3	3	6	9	12	15	18	21	24	27	0
4	4	8	12	16	20	24	28	32	36	0
5	5	10	15	20	25	30	35	40	45	0
6	6	12	18	24	30	36	42	48	54	0
7	7	14	21	28	35	42	49	56	63	0
8	8	16	24	32	40	48	56	64	72	0
9	9	18	27	36	45	54	63	72	81	0

No. 2.

1	4	7	6	8
2	8	14	12	16
3	12	21	18	24
4	16	28	24	32
5	20	35	30	40
6	24	42	36	48
7	28	49	42	56
8	32	56	48	64
9	36	63	54	72

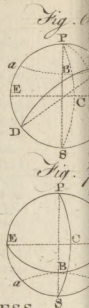


Fig. 2. NOCTURNAL.

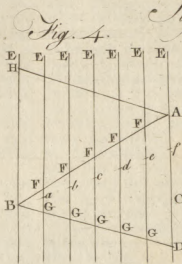
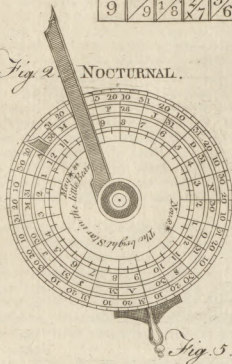


Fig. 3. OLIVE PRESS

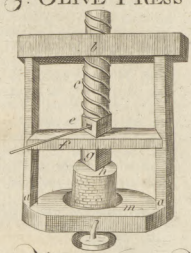


Fig. 5.

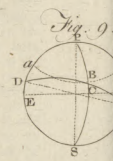
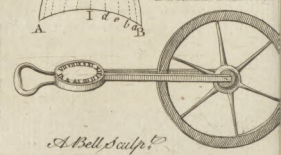


Fig. 11. PERAMBULATOR



A Bell Sculp.

## PART II. PRACTICE OF NAVIGATION.

THE main end of all practical navigation is to conduct the ship in safety to her destined port; and for this purpose it is of the utmost consequence to know in what particular part of the surface of the globe she is at any particular time. This can only be done by having an accurate map of the sea-coasts of all the countries of the world, and, by tracing out the ship's progress along the map, to know at what time she approaches the desired haven, or how she is to direct her course in order to reach it. It is therefore a matter of great importance for navigators to be furnished with maps, or *charts*, as they are called, not only very accurate in themselves, but such as are capable of having the ship's course easily traced upon them, without the trouble of laborious calculations, which are ready to create mistakes.—The names of the two great divisions of navigation are taken merely from the kind of charts made use of. Plane sailing is that in which the plane chart is made use of; and Mercator's sailing, or globular sailing, is that in which Mercator's chart is used. In both these methods, it is easy to find the ship's place with as great exactness as the chart will allow, either by the solution of a case in plane trigonometry, or by geometrical construction.

## § 1. Of Plane sailing.

As a necessary preliminary to our understanding this method of navigation, we shall here give the construction of the plane chart.

1. This chart supposes the earth to be a plane, and the meridians parallel to one another; and likewise the parallels of latitude at equal distance from one another, as they really are upon the globe. Tho' this method be in itself evidently false; yet, in a short run, and especially near the equator, an account of the ship's way may be kept by it tolerably well.

Having determined the limits of the chart, that is, how many degrees of latitude and longitude, or meridional distance (they being in this chart the same), it is to contain: suppose from the lat. of  $20^{\circ}$  N. to the lat. of  $71^{\circ}$  N.; and from the longitude of London in  $0^{\circ}$  deg. to the lon. of  $50^{\circ}$  W.; then choose a scale of equal parts, by which the chart may be contained within the size of the sheet of paper on which it is intended to be drawn. In the chart annexed, the scale is such, that each degree of latitude and longitude is  $\frac{1}{8}$  part of an inch.

Plate CCI.  
fig. 5. Make a parallelogram ABCD, the length of which AB from north to south shall contain 51 degrees, the difference of latitude between the limits of  $20^{\circ}$  and  $71^{\circ}$ ; and the breadth AD from east to west shall contain the proposed 50 degrees of longitude, the degrees being taken from the said scale of 8 degrees to an inch; and this parallelogram will be the boundaries of the chart.

About the boundaries of the chart make scales containing the degrees, halves and quarters of degrees (if the scale is large enough); drawing lines across the chart thro' every 5 or 10 degrees; let the degrees of latitude and longitude have their respective numbers

annexed, and the sheet is then fitted to receive the places intended to be delineated thereon.

On a frain slip of pasteboard, or stiff paper, let the scale of the degrees and parts of degrees of longitude, in the line AD, be laid close to the edge; and the divisions numbered from the right hand towards the left, being all west longitude.

Seek in a geographical table for the latitudes and longitudes of the places contained within the proposed limits; and let them be written out in the order in which they increase in latitude.

Then, to lay down any place, lay the edge of the pasteboard scale to the divisions on each side the chart, shewing the latitude of the place; so that the beginning of its divisions fall on the right-hand border AB; and against the division shewing the longitude of the given place make a point, and this gives the position of the place proposed; and in like manner are all the other places to be laid down.

Draw waving lines from one point to the other, where the coast is contiguous, and thus the representation of the lands within the proposed limits will be delineated.

Write the names to the respective parts, and in some convenient place insert a compass, and the chart will be completed.

2. The angle formed by the meridian and rhumb that a ship sails upon, is called the *ship's course*. Thus if a ship sails on the NNE rhumb, then her course will be  $22^{\circ} 30'$ ; and so of others.

3. The distance between two places lying on the same parallel counted in miles of the equator, or the distance of one place from the meridian of another counted as above on the parallel passing over that place, is called *meridional distance*; which, in plane sailing, goes under the name of *departure*.

4. Let A ( $n^{\circ} 3'$ ) denote a certain point on the Plate CCI. earth's surface, AC its meridian, and AD the parallel of latitude passing through it; and suppose a ship to sail from A on the NNE rhumb till she arrive at B; and through B draw the meridian BD, (which, according to the principles of plane sailing, must be parallel to CA,) and the parallel of latitude BC: then the length of AB, viz. how far the ship has sailed upon the NNE rhumb, is called her *distance*; AC or BD will be her difference of latitude, or nothing; CB will be her departure, or easting; and the angle CAB will be the course. Hence it is plain, that the distance sailed will always be greater than either the difference of latitude or departure; it being the hypotenuse of a right-angled triangle, whereof the other two are the legs; except the ship sails either on a meridian or a parallel of latitude: for if the ship sails on a meridian, then it is plain, that her distance will be just equal to her difference of latitude, and she will have no departure; but if she sail on a parallel, then her distance will be the same with her departure, and she will have no difference of latitude. It is evident also from the figure, that if the course be less than 4 points, or 45 degrees, its complement, viz. the other oblique angle, will be greater than 45 degrees, 30 E 2 and

and so the difference of latitude will be greater than the departure; but if the course be greater than 4 points, then the difference of latitude will be less than the departure; and lastly, if the course be just 4 points, the difference of latitude will be equal to the departure.

5. Since the distance, difference of latitude, and departure, form a right-angled triangle, in which the oblique angle opposite to the departure is the course, and the other its complement; therefore, having any two of these given, we can (by plain trigonometry) find the rest; and hence arise the cases of plane-sailing, which are as follow.

CASE I. Course and distance given, to find difference of latitude and departure.

EXAMPLE. Suppose a ship sails from the latitude of 30° 25' north, NNE, 32 miles, (n° 4.): Required the difference of latitude and departure, and the latitude come to. Then (by right-angle trigonometry,) we have the following analogy, for finding the departure, viz.

As radius	-	-	10.00000
to the distance AC	-	32	- 1.50515
so is the sine of the course A	22°, 30'	-	9.58284
to the departure BC	-	12.25	- 1.08799

so the ship has made 12.25 miles of departure easterly, or has got so far to the eastward of her meridian. Then for the difference of latitude or nothing the ship has made, we have (by rectangular trigonometry) the following analogy, viz.

As radius	-	-	10.00000
is to the distance AC	-	32	- 1.50515
so is the co-sine of course A	22° 30'	-	9.58284
to the difference of lat. AB	29.57	-	1.47077

so the ship has differed her latitude, or made of nothing, 29.57 minutes.

And since her former latitude was north, and her difference of latitude also north; therefore,  
To the latitude sailed from - 30°, 25' N  
add the difference of latitude - 00°, 29.57

and the sum is the latitude come to 30°, 54.57 N

By this case are calculated the tables of difference of latitude, and departure, to every degree, point, and quarter-point of the compass.

CASE II. Course and difference of latitude given, to find distance and departure.

EXAMPLE. Suppose a ship in the latitude of 45° 25' north, sails NE½N; easterly (n° 5.) till she come to the latitude of 46° 55' north: Required the distance and departure made good upon that course.

Since both latitudes are northerly, and the course also northerly; therefore,  
From the latitude come to - 46°, 55'  
subtract the latitude sailed from - 45°, 25'  
and there remains - 01°, 30'

the difference of latitude, equal to 90 miles.

And (by rectangular trigonometry) we have the following analogy, for finding the departure BD, viz.

As radius	-	-	10.00000
is to the diff. of latitude AB	-	90	- 1.95424
so is the tangent of course A	-	39°, 22'	9.91404
to the departure BD	-	73.84	1.86828

so the ship has got 73.84 miles to the eastward of her

former meridian.

Again, for the distance AD, we have (by rectangular trigonometry) the following proportion, viz.

As radius	-	-	10.00000
is to the secant of the course	39°, 22'	-	10.11176
so is the difference of latitude AB 90	-	-	1.95424
to the distance AD	-	-	116.4
			2.06600

CASE III. Difference of latitude and distance given, to find course and departure.

EXAMPLE. Suppose a ship sails from the latitude of 56° 50' north, on a rhumb between fourth and west, 126 miles, and she is then found by observation to be in the latitude of 55° 40' north: Required the course she sailed on, and her departure from the meridian. N° 6.

Since the latitudes are both north, and the ship sailing towards the equator; therefore,

From the latitude sailed from	-	56°, 50'
subtract the observed latitude	-	55°, 40'

and the remainder - 01°, 40' equal to 70 miles, is the difference of latitude.

By rectangular trigonometry we have the following proportion for finding the angle of the course F, viz.

As the distance sailed DF	-	126	- 2.10037
is to radius	-	-	10.00000
so is the diff. of latitude FD	-	70	- 1.84510
to the co-sine of the course F	-	56°, 15'	9.74473

which, because she sails between fourth and west, will be south 56° 15' west, or SW½W. Then, for the departure, we have (by rectangular trigonometry) the following proportion, viz.

As radius	-	-	10.00000
is to the distance sailed DF	-	126	- 2.10037
so is the sine of the course F	-	56°, 15'	9.91985
to the departure DE	-	104.8	- 2.02022

consequently she has made 104.8 miles of departure westerly.

CASE IV. Difference of latitude and departure given, to find course and distance.

EXAMPLE. Suppose a ship sails from the latitude of 44° 50' north, between fourth and east, till she has made 64 miles of sailing, and is then found by observation to be in the latitude of 42° 56' north: Required the course and distance made good.

Since the latitudes are both north, and the ship sailing towards the equator; therefore,

From the latitude sailed from	-	44°, 50' N
take the latitude come to	-	42°, 56'

and there remains - 01°, 54' equal to 114 miles, the difference of latitude or nothing.

In this case (by rectangular trigonometry) we have the following proportion to find the course KGL (N° 7.) viz.

As the diff. of latitude GK	114	-	2.05690
is to radius	-	-	10.00000
so is the departure KL	-	64	- 1.80618
to the tangent of course G	-	29°, 19'	9.74928

which, because the ship is sailing between fourth and east, will be south 29° 19' east, or SSE ½ east nearly.

Then for the distance, we shall have (by rectangular trigonometry) the following analogy, viz.

PRACTICE	As radius	-	-	10.00000
	is to the diff. of latitude GK	114	-	2.05690
	fo is the fecant of the course	-	29°, 19'	10.05952
	to the distance GL	-	130.8	- 2.11642
	consequently the ship has sailed on a SSE $\frac{1}{2}$ east course			130.8 miles.

CASE V. Distance and departure given, to find course and difference of latitude.

EXAMPLE. Suppose a ship at sea sails from the latitude of  $34^{\circ} 24'$  north, between north and west 124 miles, and is found to have made of westing 86 miles: Required the course steered, and the difference of latitude or nothing made good.

In this case (by rectangular trigonometry) we have the following proportion for finding the course ADB, ( $N^{\circ} 8.$ ) viz.

As the distance AD	-	124	-	2.09342
is to radius	-	-	-	10.00000
fo is the departure AB	-	86	-	1.93450
to the sine of the course D	$43^{\circ} 54'$	-	-	9.84108
fo the ship's course is north	$33^{\circ} 45'$	west, or	NW $\frac{1}{2}$ N	$\frac{1}{4}$ west nearly.

Then for the difference of latitude, we have (by rectangular trigonometry) the following analogy, viz.

As radius	-	-	-	10.00000
is to the distance AD	-	124	-	2.09342
fo is the co-sine of the course	$43^{\circ} 54'$	-	-	9.85766
to the diff. of latitude BD	-	89.35	-	1.95108
which is equal to 1 degree and 29 minutes nearly.				

Hence, to find the latitude the ship is in, since both latitudes are north, and the ship sailing from the equator; therefore,

To the latitude sailed from	-	-	-	$34^{\circ} 24'$
add the difference of latitude	-	-	-	$1^{\circ} 29'$

the sum is	-	-	-	$35^{\circ} 53'$
the latitude the ship is in north.				

CASE VI. Course and departure given, to find distance and difference of latitude.

EXAMPLE. Suppose a ship at sea, in the latitude of  $24^{\circ} 30'$  south, sails SE  $\frac{1}{2}$  S, till she has made of easting 96 miles: Required the distance and difference of latitude made good on that course.

In this case (by rectangular trigonometry and by case 2.) we have the following proportion for finding the distance, ( $N^{\circ} 9.$ ) viz.

As the sine of the course G	$33^{\circ} 45'$	-	-	9.74474
is to the departure HM	-	96	-	1.98227
fo is radius	-	-	-	10.00000
to the distance GM	-	172.8	-	2.23753

Then, for the difference of latitude, we have (by rectangular trigonometry) the following analogy, viz.

As the tangent of course	-	$33^{\circ} 45'$	-	9.82489
is to the departure HM	-	96	-	1.98227
fo is radius	-	-	-	10.00000
to the difference of latitude GH	-	143.7	-	2.15738

equal to  $2^{\circ} 24'$  nearly. Consequently, since the latitude the ship sailed from was south, and she sailing still towards the south,

To the latitude sailed from	-	-	-	$24^{\circ} 30'$
add the difference of latitude	-	-	-	$2^{\circ} 24'$

and the sum	-	-	-	$26^{\circ} 54'$
is the latitude she is come to south.				

6. When a ship sails on several courses in 24 hours,

the reducing all these into one, and thereby finding the course and distance made good upon the whole, is commonly called the *resolving of a traverse*.

7. At sea they commonly begin each day's reckoning from the noon of that day, and from that time they set down all the different courses and distances sailed by the ship till noon next day upon the log-board; then from these several courses and distances, they compute the difference of latitude and departure for each course (by *Case 1. of Plane Sailing*;) and these, together with the courses and distances, are set down in a table, called the *traverse table*, which consists of five columns: in the first of which are placed the courses and distances; in the two next, the differences of latitude belonging to these courses, according as they are north or south; and in the two last are placed the departures belonging to these courses, according as they are east or west. Then they sum up all the northings and all the southings; and taking the difference of these, they know the difference of latitude made good by the ship in the last 24 hours, which will be north or south, according as the sum of the northings or southings is greatest: the same way, by taking the sum of all the eastings, and likewise of all the westings, and subtracting the lesser of these from the greater, the difference will be the departure made good by the ship last 24 hours, which will be east or west according as the sum of the eastings is greater or less than the sum of the westings; then from the difference of latitude and departure made good by the ship last 24 hours, found as above, they find the true course and distance made good upon the whole (by *Case 4. of Plane Sailing*), as also the course and distance to the intended port.

EXAMPLE. Suppose a ship at sea, in the latitude of  $48^{\circ} 24'$  north at noon any day, is bound to a port in the latitude of  $43^{\circ} 40'$  north, whose departure from the ship is 144 miles east; consequently the direct course and distance of the ship is SSE  $\frac{1}{4}$  east 315 miles; but by reason of the shifting of the winds she is obliged to steer the following courses till noon next day, viz. SE  $\frac{1}{2}$  S 56 miles, SSE 64 miles, NW  $\frac{1}{2}$  W 48 miles, S  $\frac{1}{2}$  W  $\frac{1}{2}$  west 54 miles, and SE  $\frac{1}{2}$  S east 74 miles: Required the course and distance made good the last 24 hours, and the bearing and distance of the ship from the intended port.

The solution of this traverse depends entirely on the 1st and 4th *Cases of Plane Sailing*; and first we must (by *Case 1.*) find the difference of latitude and departure for each course. Thus,

1 Course SE  $\frac{1}{2}$  S distance 56 miles.

For departure.

As radius	-	-	-	10.00000
is to the distance	-	56	-	1.74819
fo is the sine of the course	$33^{\circ} 45'$	-	-	9.74474
to the departure	-	31.11	-	1.49293

For difference of latitude.

As radius	-	-	-	10.00000
is to the distance	-	56	-	1.74819
fo is the co-sine of the course	$33^{\circ} 45'$	-	-	9.91985
to the diff. of latitude	-	46.57	-	1.66804

2. Course SSE and distance 64 miles.

For departure.

As radius	-	-	-	10.00000
is to the distance	-	64	-	1.80618
fo is the sine of the course	-	$22^{\circ} 30'$	-	9.58284
to the departure	-	-	-	to.

PRACICE to the departure - 24.5 - 1.38902  
 For difference of latitude.  
 As radius - 10.00000  
 is to the distance - 64 - 1.80618  
 so is the co-fine of the course 22°, 30' 9.96562  
 to the difference of latitude - 59.13 - 1.77180

3. Course NW½W and distance 48 miles.

For departure.  
 As radius - 10.00000  
 is to the distance - 48 - 1.68124  
 so is the fine of the course - 56°, 15' 9.91985  
 to the departure - 39.91 - 1.60109

For difference of latitude.  
 As radius - 10.00000  
 is to the distance - 48 - 1.68124  
 so is the co-fine of the course 56°, 15' 9.74474  
 to the difference of latitude - 26.67 1.42598

4. Course S½W ¼ west and distance 54 miles.

For departure.  
 As radius - 10.00000  
 is to the distance - 54 - 1.73239  
 so is the fine of the course 16°, 52' 9.46262  
 to the departure - 15.67 - 8.19501

For difference of latitude.  
 As radius - 10.00000  
 is to the distance - 54 - 1.73239  
 so is the co-fine of the course 16°, 52' 9.98090  
 to the difference of latitude - 51.67 - 1.71329

5. Course SE½S ¼ east and distance 74 miles.

For departure.  
 As radius - 10.00000  
 is to the distance - 74 - 1.86923  
 so is the fine of the course 39°, 22' 9.80228  
 to the departure - 46.94 - 1.67151

For difference of latitude.  
 As radius - 10.00000  
 is to the distance - 74 - 1.80923  
 so is the co-fine of the course 39°, 22' 9.88824  
 to the difference of latitude 57.21 - 1.75747

Now these several courses and distances, together with the differences of latitude and departures deduced from them, being set down in their proper columns in the traverse table, will stand as follows.

The TRAVERSE TABLE.

Courses.	Distances.	Diff. of Lat.		Departure.	
		N	S	E	W
SE ½ S	56		46.57	31.11	
SSE	64		59.13	24.5	
NW ½ W	48	26.67			39.91
S ½ W ¼ W	54		51.67		15.67
SE ½ S ¼ E	94		57.21	46.94	
		26.67	214.58	102.55	55.58
			26.67	55.58	
		Diff. of Lat.	187.91	46.97	Dep.

From the above table it is plain, since the sum of the northings is 26.67, and of the southings 214.58, the difference between these, viz. 187.91, will be the southing made good by the ship the last 24 hours; also the sum of the eastings being 102.55, and of the

PRACICE westings 55.58, the difference 46.97 will be the easting or departure made good by the ship's last 24 hours; consequently, to find the true course and distance made good by the ship in that time, it will be (by Case 4. of Plane Sailing.)

As the difference of latitude - 187.91 2.27393  
 is to the radius - 10.00000  
 so is the departure - 46.97 1.67182  
 to the tangent of the course 14°, 03' 9.39789  
 which is S½E ¼ east nearly. Then for the distance, it will be,

As radius - 10.00000  
 is to the difference of latitude - 187.91 2.27393  
 so is the secant of the course - 14°, 03' 10.01319  
 to the distance - 193.7 - 2.28712

consequently the ship has made good the last 24 hours, on a S½E ¼ east course, 193.7 miles: and since the ship is sailing towards the equator; therefore,  
 From the latitude sailed from - 48°, 24' N  
 take the diff. of latitude made good - 3, 08 S

there remains - 45, 16 N  
 the latitude the ship is in north. And because the port the ship is bound for lies in the latitude of 43° 40' N, and consequently fourth of the ship; therefore,  
 From the latitude the ship is in - 45°, 16' N  
 take the latitude she is bound for - 43, 40 N

and there remains - 1, 36

or 96 miles, the difference of latitude or southing the ship has to make. Again, the whole easting the ship had to make being 144 miles, and the having already made 46.97 or 47 miles of easting; therefore the departure or easting the still has to make will be 97 miles: consequently, to find the direct course and distance between the ship and the intended port, it will be (by Case 4. of Plane Sailing.)

As the difference of latitude - 96 - 1.98227  
 is to radius - 10.00000  
 so is the departure - 97 - 1.98677  
 to the tangent of the course 45°, 19' 10.00450  
 And

As radius - 10.00000  
 is to the difference of latitude 96 - 1.98227  
 so is the secant of the course 45°, 19' 10.15293  
 to the distance 136.5 - 2.13620  
 whence the true bearing and distance of the intended port is SE, 136.5 miles.

§ 2. Of Parallel Sailing.

1. SINCE the parallels of latitude do always decrease Plate CCII.

the nearer they approach the pole, it is plain a degree on any of them must be less than a degree upon the equator. Now in order to know the length of a degree on any of them, let PB (n° 10.) represent half the earth's axis, PA a quadrant of a meridian, and consequently A a point on the equator, C a point on the meridian, and CD a perpendicular from that point upon the axis, which plainly will be the sine of CP the distance of that point from the pole, or the co-fine of CA its distance from the equator; and CD will be to AB, as the sine of CP, or co-fine of CA, is to the radius. Again, if the quadrant PAB is turned round upon the axis PB, it is plain the point A will describe the circumference of the equator whose radius is AB,

and

**PRACTICE** and any other point C upon the meridian will describe the circumference of a parallel whose radius is CD.

**COR. I.** Hence (because the circumference of circles are as their radii) it follows, that the circumference of any parallel is to the circumference of the equator, as the co-fine of its latitude is to radius.

**COR. II.** And since the wholes are as their similar parts, it will be, As the length of a degree on any parallel is to the length of a degree upon the equator, so is the co-fine of the latitude of that parallel to radius.

**COR. III.** Hence, as radius is to the co-fine of any latitude, so are the minutes of difference of longitude between two meridians, or their distance in miles upon the equator, to the distance of these two meridians on the parallel in miles.

**COR. IV.** And as the co-fine of any parallel is to radius, so is the length of any arch on that parallel (intercepted between two meridians) in miles, to the length of a similar arch on the equator, or minutes of difference of longitude.

**COR. V.** Also, as the co-fine of any one parallel is to the co-fine of any other parallel, so is the length of any arch on the first, in miles, to the length of the same arch on the other in miles.

2. From what has been said, arises the solution of the several cases of parallel sailing, which are as follows.

**CASE I.** Given the difference of longitude between two places, both lying on the same parallel; to find the distance between those places.

**EXAMPLE I.** Suppose a ship in the latitude of  $54^{\circ} 20'$  north, fails directly west on that parallel till she has differed her longitude  $12^{\circ} 45'$ ; required the distance failed on that parallel.

**Sol.** First, The difference of longitude reduced into minutes, or nautical miles, is  $765'$ , which is the distance between the meridian failed from, and the meridian come to, upon the equator; then to find the distance between these meridians on the parallel of  $54^{\circ} 20'$ , or the distance failed, it will be, by *Cor. 3.* of the last article,

As radius  $10.00000$   
is to the co-fine of the lat.  $54^{\circ} 20' - 9.76572$   
so are the minutes of diff. long.  $765 - 2.88366$   
to the distance on the parallel  $446.1 - 2.64938$

**EXAMPLE II.** A degree on the equator being 60 minutes or nautical miles; required the length of a degree on the parallel of  $51^{\circ} 32'$ .

By *Cor. 3.* of the last article, it will be  
As radius  $10.00000$   
is to the co-fine of the latitude  $51^{\circ} 32' 9.79383$   
so are the minutes in 1 degree on the equa.  $60 1.77815$   
to  $37.32 1.57198$   
the miles answering to a degree on the parallel of  $51^{\circ} 32'$

By this problem the following table is constructed, shewing the geographic miles answering to a degree on any parallel of latitude; in which you may observe, that the columns marked at the top with *D. L.* contain the degrees of latitude belonging to each parallel; and the adjacent columns marked at the top, *Miles*, contain the geographic miles answering to a degree upon these parallels.

A TABLE shewing how many Miles answer to a Degree of Longitude, at every Degree of Latitude.

D. L.	Miles.	D. L.	Miles.	D. L.	Miles.	D. L.	Miles.
1	59.99	19	56.73	37	47.92	55	34.41
2	59.97	20	56.38	38	47.28	56	33.55
3	59.92	21	56.01	39	46.62	57	32.68
4	59.86	22	55.63	40	45.95	58	31.79
5	59.77	23	55.23	41	45.28	59	30.90
6	59.67	24	54.81	42	44.95	60	30.00
7	59.56	25	54.38	43	43.88	61	29.09
8	59.44	26	53.93	44	43.16	62	28.17
9	59.26	27	53.46	45	42.43	63	27.24
10	59.08	28	52.97	46	51.68	64	26.30
11	59.89	29	52.47	47	40.92	65	25.36
12	58.68	30	51.96	48	40.15	66	24.41
13	58.46	31	51.43	49	39.36	67	23.45
14	58.22	32	50.88	50	38.57	68	22.48
15	57.95	33	50.32	51	37.76	69	21.50
16	57.67	34	49.74	52	36.94	70	20.52
17	57.36	35	49.15	53	36.11	71	19.54
18	57.06	36	48.54	54	35.26	72	18.54
						73	17.54
						74	16.53
						75	15.52
						76	14.51
						77	13.50
						78	12.48
						79	11.45
						80	10.42
						81	9.38
						82	8.35
						83	7.32
						84	6.28
						85	5.23
						86	4.18
						87	3.14
						88	2.09
						89	1.05
						90	0.00

Though this table does only shew the miles answering to a degree of any parallel, whose latitude consists of a whole number of degrees; yet it may be made to serve for any parallel whose latitude is some number of degrees and minutes, by making the following proportion, viz.

As 1 degree, or 60 minutes, is to the difference between the miles answering to a degree in the next greater and next less tabular latitude than that proposed; so is the excess of the proposed latitude above the next tabular latitude, to a proportional part; which, subtracted from the miles answering to a degree of longitude in the next less tabular latitude, will give the miles answering to a degree in the proposed latitude.

**EXAMPLE.** Required to find the miles answering to a degree on the parallel of  $56^{\circ} 44'$ .

**Sol.** First, The next less parallel of latitude in the table than that proposed, is that of  $56^{\circ}$ ; a degree of which (by the table) is equal to 33.55 miles; and the next greater parallel of latitude in the table, than that proposed, is that of  $57^{\circ}$ , a degree of which is (by the table) equal to 32.68 miles; the difference of these is 87, and the distance between these parallels is 1 degree, or 60 minutes; also the distance between the parallel of  $56^{\circ}$ , and the proposed parallel of  $56^{\circ} 44'$ , is 44 minutes: then by the preceding proportion it will be, as 60 is to 87, so is 44 to 638, the difference between a degree on the parallel of  $56^{\circ}$  and a degree on the parallel of  $56^{\circ} 44'$ ; which therefore, taken from 33.55, the miles answering to a degree on the parallel of  $56^{\circ}$ , leaves 32.92, the miles answering to a degree on the parallel of  $56^{\circ} 44'$ , as was required.

**CASE II.** The distance failed in any parallel of latitude, or the distance between any two places on that parallel, being given; to find the difference of longitude.

**EXAMPLE.** Suppose a ship in the latitude of  $55^{\circ} 36'$  north,

north sails directly east 685.6 miles: Required how much she has differed her longitude.

By Cor. 4. Art. 1. of this section, it will be  
As the co-sine of the lat. -  $55^{\circ} 36'$  - 9.75202  
is to radius - - - - - 10.00000  
so is the distance sailed - 685.6 - 2.83607  
to min. of diff. of long. - 1213 - 3.08405  
which reduced into degrees, by dividing by 60, makes  $20^{\circ} 13'$ , the difference of longitude the ship has made.

This also may be solved by help of the foregoing table, viz. by finding from it the miles answering to a degree on the proposed parallel, and dividing with this the given number of miles, the quotient will be the degrees and minutes of difference of longitude required.

Thus in the last example, we find, from the foregoing table, that a degree on the parallel of  $55^{\circ} 36'$  is equal to 33.89 miles; by this we divide the proposed number of miles 685.6, and the quotient is 20.13 degrees, i. e.  $20^{\circ} 13'$ , the difference of longitude required.

CASE III. The difference of longitude between two places on the same parallel, and the distance between them, being given; to find the latitude of that parallel.

EXAMPLE. Suppose a ship fails on a certain parallel directly west 624 miles, and then has differed her longitude  $18^{\circ} 46'$ , or 1126 miles: Required the latitude of the parallel she failed upon.

By Cor. 3. Art. 1. of this section, it will be,  
As the min. of diff. long. 1 - 126 - 3.05154  
is to the distance sailed - 624 - 2.79518  
so is radius - - - - - 10.00000  
to the co-sine of the lat. -  $56^{\circ} 21'$  - 9.74364  
consequently the latitude of the ship or parallel she failed upon was  $56^{\circ} 21'$ .

From what has been said, may be solved the following problems.

PROB. I. Suppose two ships in the latitude of  $46^{\circ} 30'$  north, distant asunder 654 miles, fail both directly north 256 miles, and consequently are come to the latitude of  $50^{\circ} 46'$  north: Required their distance on that parallel.

By Cor. 6. Art. 1. of this section, it will be,  
As the co-sine of -  $46^{\circ} 30'$  - 9.83781  
is to the co-sine of -  $50^{\circ} 46'$  - 9.80105  
so is - 654 - 2.81558  
to - 601 - 2.77882  
the distance between the ships when on the parallel of  $50^{\circ} 46'$ .

PROB. II. Suppose two ships in the latitude of  $45^{\circ} 48'$  north, distant 846 miles, fail directly north till the distance between them is 624 miles: Required the latitude come to, and the distance sailed.

By Cor. 5. Art. 1. of this section, it will be,  
As their first distance - 846 - 2.92737  
is to their second distance - 624 - 2.79518  
so is the co-sine of -  $45^{\circ} 48'$  - 9.84334  
to the cosine - 59.04 - 9.71115  
the latitude of the parallel the ships are come to.

Consequently to find their distance sailed,  
From the latitude come to -  $59^{\circ} 04'$   
subtract the latitude sailed from - 45, 48

and there remains = - 13, 16

equal to 796 miles, the difference of latitude or distance sailed.

§ 3. Of Middle-latitude Sailing.

1. WHEN two places lie both on the same parallel, we shewed in the last section, how, from the difference of longitude given, to find the miles of sailing or walking between them, *et contra*. But when two places lie not on the same parallel, then their difference of longitude cannot be reduced to miles of sailing or walking on the parallel of either place; for if counted on the parallel of that place that has the greatest latitude, it would be too small; and if on the parallel of that place having the least latitude, it would be too great. Hence the common way of reducing the difference of longitude between two places, lying on different parallels, to miles of sailing or walking, *et contra*, is by counting it on the middle parallel between the places, which is found by adding the latitudes of the two places together, and taking half the sum, which will be the latitude of the middle parallel required. And hence arises the solution of the following cases.

CASE I. The latitudes of two places, and their difference of longitude, given; to find the direct course and distance.

EXAMPLE. Required the direct course and distance between the Lizard in the latitude of  $50^{\circ} 00'$  north, and longitude of  $5^{\circ} 14'$  west, and St Vincent in the latitude of  $17^{\circ} 10'$  N. and longitude of  $24^{\circ} 20'$  W.

Firft, To the latitude of the Lizard	$50^{\circ} 00'$ N.	
add the latitude of St Vincent	- 17, 10	
<hr/>		
The sum is	- 67, 10	
Half the sum or latitude of		
the middle parallel is	- 33, 35 N.	
Also the difference of latitude is	- 33, 50	
equal to 1970 miles of southing.	Again,	
From the longitude of St Vincent	- 24, 20 W.	
take the longitude of the Lizard	- 05, 14	
<hr/>		
there remains	- 16, 06	

equal to 1146 min. of diff. of long. west.

Then for the miles of walking, or departure, it will be, (by Case 1. of Parallel Sailing)

As radius	- 10.00000	
is to the co-sine of the		
middle parallel	- 33, 35 - 9.92069	
so is min. diff. of long. - 1146	- 3.05918	
to the miles of walking - 954.7	- 2.97987	

And for the course it will be, (by Case 4. of Plane Sailing)

As the diff. of lat. - 1970	- 3.29447
is to radius - 10.00000	
so is the departure - 954.7	- 2.97987
to the tang. of the course $25^{\circ} 51'$	- 9.68540

which, because it is between south and west, it will be SSW  $\frac{1}{2}$  west nearly.

For the distance, it will be, by the same case,  
As radius - 10.00000  
is to the diff. of lat. - 1970 - 3.29447  
so is the secant of the course  $25^{\circ} 51'$  - 10.04579  
to the distance - 2189 - 3.34026

whence the direct course and distance from the Lizard to St Vincent is SSW  $\frac{1}{2}$  2189 W miles.

CASE II. One latitude, course, and distance sailed being



*Practise being given*; to find the other latitude and difference of longitude.

**EXAMPLE.** Suppose a ship in the latitude of  $50^{\circ} 00'$  north, fails south  $50^{\circ} 06'$  west, 150 miles: Required the latitude the ship has come to, and how much she has differed her longitude.

First, For the difference of latitude, it will be, (by *Case 1. of Plane Sailing,*)

As radius	-	-	10.00000
is to the distance	-	150	- 2.17609
fo is the co-fine of the course	$50^{\circ}, 06'$	-	9.80716
to the diff. of latitude	-	96.22	- 1.98325

equal to  $1^{\circ}, 36'$ . And since the ship is sailing towards the equator; therefore,  
From the latitude she was in  $50^{\circ}, 00'$   
take the diff. of latitude  $1, 36$

and there remains  $48, 24$   
the latitude she has come to north. Consequently the latitude of the middle parallel will be  $49^{\circ} 12'$ .

Then for departure or wetting it will be, by the same *Case,*

As radius	-	-	10.00000
is to the distance	-	150	- 2.17609
fo is the fine of the course	$50^{\circ}, 06'$	-	9.88489
to the departure	-	115.1	- 2.06098

As for the difference of longitude, it will be, (by *Case 2. of Plane Sailing,*)

As the co-fine of the middle parallel	$49^{\circ} 12'$	-	9.81519
is to radius	-	-	10.00000
fo is the departure	-	115.1	- 2.06098
to the min. diff. of longitude	-	176.1	- 2.24579

equal to  $2^{\circ} 56'$ , which is the difference of longitude the ship has made westerly.

**CASE III.** Course and difference of latitude given; to find the distance failed, and difference of longitude.

**EXAMPLE.** Suppose a ship in the latitude of  $53^{\circ} 34'$  north, fails SE&S, till by observation she is found to be in the latitude of  $51^{\circ} 12'$ , and consequently has differed her latitude  $2^{\circ} 22'$ , or 142 miles: Required the distance failed, and the difference of longitude.

First, for the departure, it will be, (by *Case 2. of Plane Sailing,*)

As radius	-	-	10.00000
is to the diff. of latitude	-	142	- 2.15229
fo is the tang. of course	$33^{\circ}, 45'$	-	9.82489
to the departure	-	94.88	- 1.97718

And for the distance it will be, (by the same *Case,*)

As radius	-	-	10.00000
is to the diff. of latitude	-	142	- 2.15229
fo is the secant of the course	$33^{\circ}, 45'$	-	10.08015
to the distance	-	170.8	- 2.23244

Then, since the latitude failed from was  $53^{\circ} 34'$  north, and the latitude come to  $51^{\circ} 12'$  north; therefore the middle parallel will be  $52^{\circ} 23'$ ; and consequently, for the difference of longitude, it will be (by *Case 2. of Parallel Sailing,*)

As the co-fine of the mid. parallel	$52^{\circ}, 23'$	-	9.78560
is to the departure	-	94.88	- 1.97718
fo is radius	-	-	10.00000
to min. of diff. of longitude	-	155.5	- 2.19158

equal to  $2^{\circ} 35'$  the difference of longitude easterly.

**CASE IV.** Difference of latitude and distance fail-

VOL. VII.

2

ed, given; to find the course and difference of longitude.

**EXAMPLE.** Suppose a ship in the latitude of  $43^{\circ} 26'$  north, fails between south and east, 246 miles, and then is found by observation to be in the latitude of  $41^{\circ} 06'$  north: Required the direct course and difference of longitude.

First, For the course, it will be, (by *Case 3. of Plane Sailing,*)

As the distance	-	246	- 2.39094
is to radius	-	-	10.00000
fo is the diff. of latitude	-	140	- 2.14613
to the co-fine of the course	$55^{\circ}, 19'$	-	9.75519

which, because the ship fails between south and east, will be south  $55^{\circ} 19'$  east, or SE&E nearly.

Then for departure, it will be, by the same *Case,*

As radius	-	-	10.00000
is to the distance	-	246	- 2.39094
is the fine of the course	$55^{\circ}, 19'$	-	9.91504
to the departure	-	202.3	- 2.30598

Lastly, For the difference of longitude, it will be, (by *Case 2. of Parallel Sailing,*)

As the co-fine of the mid. par.	$42^{\circ}, 16'$	-	9.86924
is to the departure	-	302.3	- 2.30598
fo is radius	-	-	10.00000
to min. of diff. of longitude	-	273.3	- 2.43674

equal to  $4^{\circ} 33'$ , the difference of longitude easterly.

**CASE V.** Course and departure given, to find difference of latitude, difference of longitude, and distance failed.

**EXAMPLE.** Suppose a ship in the latitude of  $48^{\circ} 23'$  north, fails SW&S, till she has made of wetting 123 miles: Required the latitude come to, the difference of longitude, and the distance failed.

First, For the distance, it will be, (by *Case 6. of Plane Sailing,*)

As the fine of the course	$33^{\circ}, 45'$	-	6.74474
is to the departure	-	123	- 2.08991
fo is radius	-	-	10.00000
to the distance	-	221.4	- 2.34517

And for the difference of latitude, it will be, by the same *Case,*

As the tang. of course	$33^{\circ}, 45'$	-	9.82489
is to the departure	-	123	- 2.08991
fo is radius	-	-	10.00000
to the diff. of latitude	-	184	- 2.26502

equal to  $3^{\circ} 04'$ : And since the ship is failing towards the equator, the latitude come to will be  $45^{\circ} 19'$  north; and consequently the middle parallel will be  $46^{\circ} 51'$ .

Then to find the difference of longitude, it will be, (by *Case 2. of Parallel Sailing,*)

As the co-fine of mid. par.	$46^{\circ}, 51'$	-	9.83550
is to the departure	-	123	- 2.08991
fo is radius	-	-	10.00000
to min. of diff. of longit.	-	180	- 2.25491

which is equal to  $3^{\circ} 00'$ , the difference of longitude westerly.

**CASE VI.** Difference of latitude and departure given, to find course, distance, and difference of longitude.

**EXAMPLE.** Suppose a ship in the latitude of  $46^{\circ} 37'$  north, fails between south and east, till she has made of sailing 146 miles, and is then found by observation to be in the latitude of  $43^{\circ} 24'$  north:

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**PRACTICE** Required the course, distance, and difference of longitude.

First, By *Case 4. of Plane Sailing*, it will be for the course,

As the diff. of latitude - 193 - 2.28556  
is to departure - 146 - 2.16137  
so is radius - - - 10.00000  
to the tang. of the course  $36^{\circ} 55'$  - 9.87581  
which, because the ship is sailing between south and east, will be south  $36^{\circ} 55'$  east, or *SE $\frac{1}{2}$ E* east nearly.

For the distance, it will be, by the same *Case*,

As radius - - - 10.00000  
is to the diff. of latitude 193 - 2.28556  
so is the secant of the course  $36^{\circ} 55'$  - 10.09718  
to the distance - 241.4 - 2.38274

Then for the difference of longitude, it will be, by *Case 2. of Parallel Sailing*,

As the co-line of the mid. par.  $45^{\circ} 00'$  9.84949  
is to the departure - 146 - 2.16137  
so is radius - - - 10.00000  
to min. of diff. of longitude 205 - 2.31188  
equal to  $3^{\circ} 25'$ , the difference of longitude easterly.

**CASE VII.** Distance and departure given, to find difference of latitude, course, and difference of longitude.

**EXAMPLE.** Suppose a ship in the latitude of  $33^{\circ} 40'$  north, fails between south and east 165 miles, and has then made of easting 112.5 miles: Required the difference of latitude, course, and difference of longitude.

First, for the course, it will be, by *Case 5. of Plane Sailing*,

As the distance - 165 - 2.21748  
is to radius - - - 10.00000  
so is the departure 102.5 - 2.05115  
to the sine of the course  $42^{\circ} 59'$  - 9.83367  
which, because the ship fails between south and east, will be south  $42^{\circ} 59'$  east, or *SE $\frac{1}{2}$ E* east nearly.

And for the difference of latitude, it will be, by the same *Case*,

As radius - - - 10.00000  
is to the distance - 165 - 2.21748  
so is the co-sine of the course  $42^{\circ} 59'$  - 9.86436  
to the difference of lat. - 120.7 - 2.08184

equal to  $2^{\circ} 00'$ ; consequently the latitude come to will be  $31^{\circ} 40'$  north, and the latitude of the middle parallel will be  $32^{\circ} 40'$ . Hence, to find the difference of longitude, it will be, by *Case 2. of Parallel Sailing*,

As the co-line of the mid. par.  $32^{\circ} 40'$  9.92522  
is to the departure - 112.5 - 2.05115  
so is radius - - - 10.00000  
to min. of diff. of long. - 133.6 - 2.12593  
equal to  $2^{\circ} 13'$  nearly, the difference of longitude easterly.

**CASE VIII.** Difference of longitude and departure given; to find difference of latitude, course, and distance failed.

**EXAMPLE.** Suppose a ship in the latitude of  $50^{\circ} 46'$  north, fails between south and west, till her difference of longitude is  $3^{\circ} 12'$ , and is then found to have departed from her former meridian 126 miles; required the difference of latitude, course, and distance failed.

First, For the latitude she has come to, it will be, **PRACTICE**

by *Case 3. of Parallel Sailing*,  
As min. of diff. of long. - 192 - 2.28330  
is to departure - 126 - 2.10037  
so is radius - - - 10.00000  
to the co-sine of the mid. par.  $48^{\circ} 59'$  9.81707

Now since the middle latitude is equal to half the sum of the two latitudes (by art. 1. of this sect.) and so the sum of the two latitudes equal to double the middle latitude; it follows, that if from double the middle latitude we subtract any one of the latitudes, the remainder will be the other. Hence from twice  $48^{\circ} 59'$ , viz.  $97^{\circ} 58'$ , taking  $50^{\circ} 46'$  the latitude failed from, there remains  $47^{\circ} 12'$  the latitude come to; consequently the difference of latitude is  $3^{\circ} 34'$ , or 214 minutes.

Then for the course, it will be, by *Case 4. of Plane Sailing*,

As diff. of lat. - 214 - 2.33041  
is to radius - - - 10.00000  
so is the departure - 126 - 2.10037  
to the tang. of the course  $30^{\circ} 29'$  - 9.76996  
which, because it is between south and west, will be south  $30^{\circ} 29'$  west, or *SSW $\frac{1}{2}$ W* west nearly.

And for the distance, it will be, by the same *Case*,

As radius - - - 10.00000  
is to the diff. of lat. - 214 - 2.33041  
so is the secant of the course  $30^{\circ} 29'$  - 10.06461  
to the distance - 248.4 - 2.39502

2. From what has been said, it will be easy to solve a traverse, by the rules of *Middle-latitude Sailing*.

**EXAMPLE.** Suppose a ship in the latitude of  $43^{\circ} 25'$  north, fails upon the following courses, viz. *SW $\frac{1}{2}$ S* 63 miles, *SSW $\frac{1}{2}$ W* east 45 miles, *S $\frac{1}{2}$ E* 54 miles, and *SW $\frac{1}{2}$ W* 74 miles: Required the latitude the ship has come to, and how far she has differed her longitude.

First, By *Case 2. of this Sect.* find the difference of latitude and difference of longitude belonging to each course and distance, and they will stand as in the following table.

Courses.	Distances.	Diff. of Lat.		Diff. of Longit.	
		N	S	E	W
SW $\frac{1}{2}$ S	— 63		52.4		47.85
SSW $\frac{1}{2}$ W	— 45		39.7		28.62
S $\frac{1}{2}$ E	— 54		53.0	14.75	
SW $\frac{1}{2}$ W	— 74		41.1		81.08
					157.55
					13.75
		Diff. of Lat.	186.2		
				Diff. of Long.	143.80

Hence it is plain the ship has differed her latitude 186.2 minutes, or  $3^{\circ} 6'$ , and so has come to the latitude of  $40^{\circ} 19'$  north, and has made of difference of longitude 143.8 minutes, or  $2^{\circ} 23' 48''$  westerly.

3. This method of sailing, though it be not strictly true, yet it comes very near the truth, as will be evident, by comparing an example wrought by this method with the same wrought by the method deli-

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**PRACTICE** vered in the next section, which is strictly true; and it serves, without any considerable error, in runnings of 450 miles between the equator and parallel of 30 degrees, of 300 miles between that and the parallel of 60 degrees, and of 150 miles as far as there is any occasion, and consequently must be sufficiently exact for 24 hours run.

#### §. 4. Of Mercator's sailing.

1. THOUGH the meridians do all meet at the pole, and the parallels to the equator do continually decrease, and that in proportion to the co-sines of their latitudes; yet in old sea-charts the meridians were drawn parallel to one another, and consequently the parallels of latitude made equal to the equator, and so a degree of longitude on any parallel as large as a degree on the equator: also in these charts the degrees of latitude were still represented (as they are in themselves) equal to each other, and to those of the equator. By these means the degrees of longitude being increased beyond their just proportion, and the more so the nearer they approach the pole, the degrees of latitude at the same time remaining the same, it is evident places must be very erroneously marked down upon these charts with respect to their latitude and longitude, and consequently their bearing from one another very false.

2. To remedy this inconvenience, so as still to keep the meridians parallel, is in plain we must protract, or lengthen, the degrees of latitude in the same proportion as those of longitude are, that so the proportion in sailing and westing may be the same with that of southing and northing, and consequently the bearings of places from one another be the same upon the chart as upon the globe itself.

**PLATE CCII.** Let ABD (No 11.) be a quadrant of a meridian, A the pole, D a point on the equator, AC half the axis, B any point upon the meridian, from which draw BF perpendicular to AC, and BG perpendicular to CD; then BG will be the sine, and BF or CG the co-sine of BD the latitude of the point B; draw D the tangent and CE the secant of the arch CD. It has been demonstrated in Sect. 2. that any arch of a parallel is to the like arch of the equator as the co-sine of the latitude of that parallel is to radius. Thus any arch as a minute on the parallel described by the point B, will be to a minute on the equator as BF or CG is to CD; but since the triangles CGB CDE are similar, therefore CG will be to CD as CB is to CE, *i. e.* the co-sine of any parallel is to radius as radius is to the secant of the latitude of that parallel. But it has been just now shown, that the co-sine of any parallel is to radius, as the length of any arch as a minute on that parallel is to the length of the like arch on the equator: therefore the length of any arch as a minute on any parallel, is to the length of the like arch on the equator, as radius is to the secant of the latitude of that parallel; and so the length of any arch, as a minute on the equator, is longer than the like arch of any parallel in the same proportion as the secant of the latitude of that parallel is to radius. But since in this projection the meridians are parallel, and consequently each parallel of latitude equal to the equator, it is plain the length of any arch as a minute on any parallel, is increased beyond its

**PRACTICE** just proportion, at such rate as the secant of the latitude of that parallel is greater than radius; and therefore, to keep up the proportion of northing and southing to that of sailing and westing, upon this chart, as it is upon the globe itself, the length of a minute upon the meridian at any parallel must also be increased beyond its just proportion at the same rate, *i. e.* as the secant of the latitude of that parallel is greater than radius. Thus to find the length of a minute upon the meridian at the latitude of 75 degrees, since a minute of a meridian is every-where equal on the globe, and also equal to a minute upon the equator, let it be represented by unity; then making it as radius is to the secant of 75 degrees, so is unity to a fourth number, which is 3.864 nearly; and consequently, by whatever line you represent one minute on the equator of this chart, the length of one minute on the enlarged meridian at the latitude of 75 degrees, or the distance between the parallel of 75° 00' and the parallel of 75° 01', will be equal to 3 of these lines, and  $\frac{864}{1000}$  of one of them. By making the same proportion, it will be found, that the length of a minute on the meridian of this chart at the parallel of 60°, or the distance between the parallel of 60° 00' and that of 60° 01', is equal to two of these lines. After the same manner, the length of a minute on the enlarged meridian may be found at any latitude; and consequently, beginning at the equator, and computing the length of every intermediate minute between that and any parallel, the sum of all these shall be the length of a meridian intercepted between the equator and that parallel; and the distance of each degree and minute of latitude from the equator upon the meridian of this chart, computed in minutes of the equator, forms what is commonly called a *table of meridional parts*.

If the arch BD (No 11.) represent the latitude of any point B, then (CD being radius) CE will be the secant of that latitude: but it has been shown above, that radius is to secant of any latitude, as the length of a minute upon the equator is to the length of a minute on the meridian of this chart at that latitude; therefore CD is to CE, as the length of a minute on the equator is to the length of a minute upon the meridian, at the latitude of the point B. Consequently, if the radius CD be taken equal to the length of a minute upon the equator, CE, or the secant of the latitude, will be equal to the length of a minute upon the meridian at that latitude. Therefore, in general, if the length of a minute upon the equator be made radius, the length of a minute upon the enlarged meridian will be every-where equal to the secant of the arch contained between it and the equator.

**COR. 1.** Hence it follows, since the length of every intermediate minute between the equator and any parallel, is equal to the secant of the latitude, (the radius being equal to a minute upon the equator), the sum of all these lengths, or the distance of that parallel on the enlarged meridian from the equator, will be equal to the sum of all the secants, to every minute contained between it and the equator.

**COR. 2.** Consequently the distance between any two parallels on the same side of the equator is equal to the difference of the sums of all the secants contained be-

PRACTICE

tween the equator and each parallel, and the distance between any two parallels on contrary sides of the equator is equal to the sum of the sums of all the secants contained between the equator and each parallel.

3. By the tables of meridional parts given by all the writers on this subject, may be constructed the nautical chart, commonly called *Mercator's chart*. Thus, for example, let it be required to make a chart that shall commence at the equator, and reach to the parallel of 60 degrees, and shall contain 80 degrees of longitude.

Draw the line EQ representing the equator, (see N° 12.): then take, from any convenient line of equal parts, 4800, (the number of minutes containing in 80 degrees), which set off from E to Q, and this will determine the breadth of the chart.

Divide the line EQ into eight equal parts, in the points 10, 20, 30, &c, each containing 10 degrees; and each of these divided into 10 equal parts, will give the single degrees upon the equator: then through the points E, 10, 12, &c. drawing lines perpendicular to EQ, these shall be meridians.

From the scale of equal parts take 4527.4, (the meridional parts answering to 60 degrees), and let that off from E to A and from Q to B, and join AB; then this line will represent the parallel of 60, and will determine the length of the chart.

Again, from the scale of equal parts take 603.1, (the meridional parts answering to 10 degrees), and set that off from E to 10 on the line EA; and through the point 10 draw 10, 10, parallel to EQ; and this will be the parallel of 10 degrees. The same way, setting off from E on the line EA, the meridional parts answering to each degree, &c, of latitude, and through the several points drawing lines parallel to EQ, we shall have the several parallels of latitude.

If the chart does not commence from the equator, but is only to serve for a certain distance on the meridian between two given parallels on the same side of the equator; then the meridians are to be drawn as in the last example: and for the parallels of latitude you are to proceed thus, viz. From the meridional parts answering to each point of latitude in your chart subtract the meridional parts answering to the least latitude, and set off the differences severally, from the parallel of the least latitude, upon the two extreme meridians; and the lines joining these points of the meridians shall represent the several parallels upon your chart.

Thus let it be required to draw a chart that shall serve from the latitude of 20 degrees north to 60 degrees north, and that shall contain 80 degrees of longitude.

Having drawn the line DC to represent the parallel of 20 degrees (see N° 12.) and the meridians to it, as in the foregoing example; set off 663.3 (the difference between the meridional parts answering to 30 degrees, and those of 20 degrees) from D to 30, and from C to 30; then join the points 30 and 30 with a right line, and that shall be the parallel of 30. Also set off 1397.6 (the difference between the meridional parts answering to 40 degrees, and those of 20 degrees) from D to 40, and from C to 40; and joining the points 40 and 40 with a right line, that shall be the parallel

of 40. And proceeding after the same way, we may draw as many of the intermediate parallels as we have occasion for.

But if the two parallels of latitude that bound the chart, are on the contrary sides of the equator; then draw a line representing the equator and meridians to it, as in the first example; and from the equator set off on each side of it the several parallels contained between it and the given parallels as above, and your chart is finished.

If Mercator's chart, constructed as above, hath its equator extended on each side of the point E 180 degrees, and if the several places on the surface of the earth be there laid down according to their latitudes and longitudes, we shall have what is commonly called *Mercator's map of the earth*. This map is not to be considered as a similar and just representation of the earth's surface; for in it the figures of countries are distorted, especially near the poles: but since the degrees of latitude are every where increased in the same proportion as those of longitude are, the bearings between the places will be the same in this chart as on the globe; and the proportions between the latitudes, longitudes, and nautical distances, will also be the same on this chart, as on the globe itself; by which means the several cases of navigation are solved after a most easy manner, and adapted to the meanest capacities.

N. B. Here you must take notice, that in all charts the upper part is the north side, and the lower part or bottom is the south side; also that part of it towards the right-hand is the east, and that towards the left-hand the west side of the chart.

4. Since, according to this projection, the meridians are parallel right lines; it is plain, that the rhumbs which form always equal angles with the meridians, will be freight lines; which property renders this projection of the earth's surface much more easy and proper for the use than any other.

5. This method of projecting the earth's surface upon a plane, was first invented by Mr Edward Wright, but first published by Mercator; and hence the sailing by the chart was called *Mercator's sailing*.

6. In N° 13. let A and E represent two places upon Mercator's chart, AC the meridian of A, and CE the parallel of latitude passing through E; draw AE, and set off upon AC the length AB equal to the number of minutes contained in the difference of latitude between the two places, and taken from the same scale of equal parts the chart was made by, or from the equator, or any graduated parallel of the chart, and through B draw BD parallel to CE meeting AE in D. Then AC will be the enlarged difference of latitude, AB the proper difference of latitude, CE the difference of longitude, BD the departure, AE the enlarged distance, and AD the proper distance, between the two places A and E; also the angle BAD will be the course, and AE the rhumb-line between them.

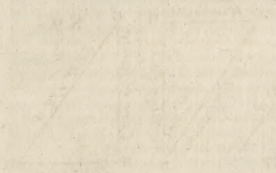
7. Now since in the triangle ACE, BD is parallel to one of its sides CE; it is plain the triangles ACE, ABD, will be similar, and consequently the sides proportional. Hence arise the solutions of the several cases in this sailing, which are as follow.

CASE I. The latitudes of two places given, to find the meridional or enlarged difference of latitude between

between

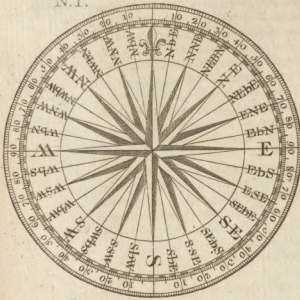
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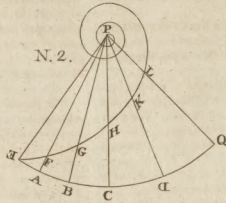


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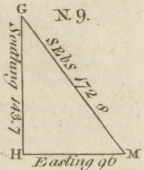
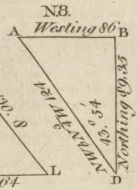
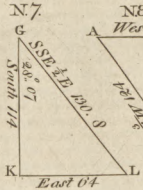
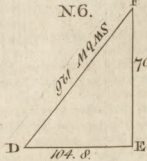
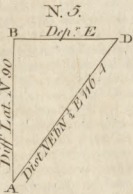
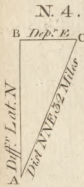
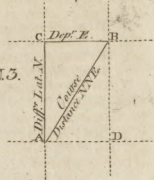
N.1.



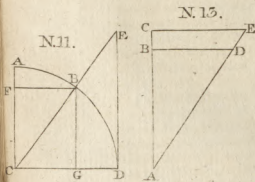
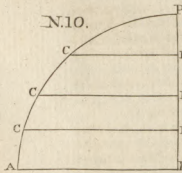
N.2.



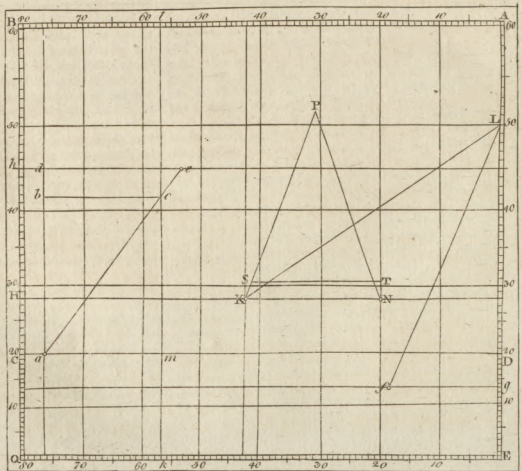
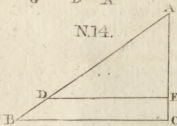
N.3.



N.12.



N.14.



PRACTICE *tween them.*

Of this case there are three varieties, *viz.* either one of the places lies on the equator, or both on the same side of it; or lastly, on different sides.

1. If one of the proposed places lies on the equator, then the meridional difference of latitude is the same with the latitude of the other place, taken from the table of meridional parts.

EXAMPLE. Required the meridional difference of latitude between St Thomas, lying on the equator, and St Antonio in the latitude of  $17^{\circ} 20'$  north. We look in the tables for the meridional parts answering to  $17^{\circ} 20'$ , and find it to be 1056.2, the enlarged difference of latitude required.

2. If the two proposed places be on the same side of the equator, then the meridional difference of latitude is found by subtracting the meridional parts answering to the least latitude from those answering to the greatest, and the difference is that required.

EXAMPLE. Required the meridional difference of latitude between the Lizard in the latitude of  $50^{\circ} 00'$  north, and Antigua in the latitude of  $17^{\circ} 30'$  north. From the meridional parts of  $50^{\circ}, 00'$  - 3474.5 subtract the meridional parts of  $17, 30$  - 1066.7

there remains - - - 2407.8  
the meridional difference of latitude required.

3. If the places lie on different sides of the equator, then the meridional difference of latitude is found by adding together the meridional parts answering to each latitude, and the sum is that required.

EXAMPLE. Required the meridional difference of latitude between Antigua in the latitude of  $17^{\circ} 30'$  north, and Lima in Peru in the latitude of  $12^{\circ} 30'$  south.

To the merid. parts answering to  $17^{\circ}, 30'$  1066.7  
add these answering to  $12, 30$  756.1

the sum is - - - 1822.8  
the meridional difference of latitude required.

CASE II. The latitudes and longitudes of two places given, to find the direct course and distance between them.

EXAMPLE. Required to find the direct course and distance between the Lizard in the latitude of  $50^{\circ} 00'$  north, and Port-Royal in Jamaica in the latitude of  $17^{\circ} 40'$ ; differing in longitude  $70^{\circ} 46'$ , Port-Royal lying so far to the westward of the Lizard.

PREPARATION.

From the latitude of the Lizard -  $50^{\circ}, 00'$   
subtract the latitude of Port-Royal -  $17, 40$

and there remains - - - 32, 20  
equal to 1940 minutes, the proper difference of latitude.

Then from the meridional parts of  $50^{\circ}, 00'$  3474.5  
subtract those of  $17, 40$  1077.2

and there remains - - - 2397.3  
the meridional or enlarged difference of longitude.

GEOMETRICALLY. Draw the line AC (N<sup>o</sup> 14.) representing the meridian of the Lizard at A, and set off from A, upon that line, AE equal to 1940 (from any scale of equal parts) the proper difference of latitude, also AC equal to 2397.3 (from the same scale) the

meridional or enlarged difference of latitude. Upon the point C raise CB perpendicular to AC, and make CB equal to 4246, the minutes of difference of longitude.

Join AB, and through E draw ED parallel to BC; so the case is constructed; and AD applied to the same scale of equal parts the other legs were taken from, will give the direct distance, and the angle DAE measured by the line of chords will give the course.

BY CALCULATION.

For the angle of the course EAD, it will be, (by rectangular trigonometry.)

AC : CB :: R : T, BAC, *i. e.*

As the meridional diff. of lat. 2397.3 - 3.37970  
is to the difference of long. 4246.0 - 3.62798  
so is radius - - - 10.00000

to the tang. of the direct course  $60^{\circ} 33'$  10.34828  
which, because Port-Royal is southward of the Lizard, and the difference of longitude westerly, will be south  $60^{\circ} 33'$  west, or SW $\frac{1}{4}$ W  $\frac{1}{4}$  west nearly.

Then for the distance AD, it will be, (by rectangular trigonometry),

R : AE :: Sec. A : AD, *i. e.*

As the radius - - - 10.00000  
is the proper diff. of lat. - 1940 - 3.28780

so is the secant of the course -  $60^{\circ}, 33'$  10.30833  
to the distance - - - 3945.6 3.59613  
consequently the direct course and distance between the Lizard and Port-Royal in Jamaica, is south  $60^{\circ} 33'$ , 3945.6 miles.

CASE III. Course and distance failed given, to find difference of latitude and difference of longitude.

EXAMPLE. Suppose a ship from the Lizard in the latitude of  $50^{\circ} 00'$  north, sails south  $35^{\circ} 40'$  west 156 miles: Required the latitude come to, and how much she has altered her longitude.

GEOMETRICALLY. 1. Draw the line BK (N<sup>o</sup> 15;) Plate CCIII representing the meridian of the Lizard at B; from B draw the line BM, making with BK an angle equal to  $35^{\circ} 40'$ , and upon this line set off BM equal to 156 the given distance, and from M let fall the perpendicular MK upon BK.

Then for BK the proper difference of latitude, it will be, (by rectangular trigonometry,)

R : MB :: S, BMK : BK,

*i. e.* As radius - - - 10.00000  
is to the distance - 156 - 2.19312

so is the co-sine of the course  $35^{\circ}, 40'$  - 9.90978  
to the proper difference of lat. 127 - 2.10290  
equal to  $2^{\circ} 07'$ ; and since the ship is sailing from a north latitude towards the south, therefore the latitude come to will be  $47^{\circ} 53'$  north. Hence the meridional difference of latitude will be 193.4.

2. Produce BK to D, till BD be equal to 193.4; through D draw DL parallel to MK, meeting DM produced in L; then DL will be the difference of longitude: to find which by calculation, it will be, (by rectangular trigonometry,)

R : BD :: T, LBD : DL,

*i. e.* As radius - - - 10.00000  
is to the meridional diff. of lat. 193.4 - 2.28646  
so is the tangent of the course  $35^{\circ}, 40'$  9.85594  
to minutes of diff. of long. - 138.8 - 2.14240  
equal to  $2^{\circ} 18' 48''$ , the difference of longitude the ship has made westerly.

CASE IV. Given course and both latitudes, *viz.* the

la-

PRACTICE

latitude failed from, and the latitude come to; to find the distance failed, and the difference of longitude.

**EXAMPLE.** Suppose a ship in the latitude of  $50^{\circ} 20'$  north, fails south  $33^{\circ} 45'$  east, until by observation she is found to be in the latitude of  $51^{\circ} 45'$  north: Required the distance failed, and the difference of longitude.

**GEOMETRICALLY.** Draw AB ( $N^{\circ} 16.$ ) to represent the meridian of the ship in the first latitude, and set off from A to B 155 the minutes of the proper difference of latitude, also AG equal to 257.9 the minutes of the enlarged difference of latitude. Through B and G, draw the lines BC and GK perpendicular to AG; also draw AK, making with AG an angle of  $33^{\circ} 45'$ , which will meet the two former lines in the points C and K; so the case is constructed, and AC and GK may be found from the line of equal parts: To find which,

By CALCULATION;

First, For the difference of longitude, it will be, (by rectangular trigonometry.)

$$R : AG :: T, GAK : GK,$$

*i. e.* As radius - - - - - 10.00000  
is to the enlarged diff. of lat. 257.9 - 2.41145  
so is the tang. of the course  $33^{\circ}, 45'$  - 9.82489  
to min. of diff. of longitude 172.3 - 2.23634  
equal to  $2^{\circ} 52' 18''$ , the difference of longitude the ship has made easterly.

This might also have been found, by first finding the departure BC, (by *Case 2. of Plane Sailing*), and then it would be

AB : BC :: AG : GK, the difference of longitude required.

Then for the direct distance AC, it will be, (by rectangular trigonometry.)

$$R : AB :: \text{Sec. } A : AC,$$

*i. e.* As radius - - - - - 10.00000  
is to the proper diff. of lat. - 155 - 2.10033  
so is the secant of the course  $33^{\circ}, 45'$  10.08015  
to the direct distance - 186.4 - 2.27048  
consequently the ship has failed south  $33^{\circ} 45'$  east 186.4 miles, and has differed her longitude  $2^{\circ} 52' 18''$  easterly.

**CASE V.** both latitudes, and distance failed, given; to find the direct course, and difference of longitude.

**EXAMPLE.** Suppose a ship from the latitude of  $45^{\circ} 26'$  north, fails between north and east 195 miles, and then by observation she is found to be in the latitude of  $48^{\circ} 6'$  north: Required the direct course and difference of longitude.

**GEOMETRICALLY.** Draw AB ( $n^{\circ} 17.$ ) equal to 160 the proper difference of latitude, and from the point B raise the perpendicular BD; then take 195 in your compasses, and setting one foot of them in A, with the other cross the line BD in D. Produce AB, till AC be equal to 233.6 the enlarged difference of latitude. Through C draw CK parallel to BD, meeting AD produced in K: so the case is constructed; and the angle A may be measured by the line of chords, and CK by the line of equal parts: To find which,

By CALCULATION:

First, For the angle of the course BAD, it will be (by rectangular trigonometry,)

$$AB : R :: AD : \text{Sec. } A. \text{ } i. e.$$

As the proper diff. of lat. - 160 - 2.20412

is to radius - - - - - 10.00000 PRACTICE  
so is the distance - 195 - 2.29003  
to the secant of the course -  $34^{\circ}, 52'$  10.08591  
which, because the ship is failing between north and east, will be north  $34^{\circ} 52'$  east, or NEEN  $1^{\circ} 7'$  easterly.

Then for the difference of longitude, it will be, (by rectangular trigonometry,)

$$R : AC :: T, A : CK.$$

*i. e.* As radius - - - - - 10.00000  
is to the merid. diff. of lat. - 233.6 - 2.36847  
so is the tang. of the course  $34^{\circ}, 52'$  9.84307  
to min. of diff. of longitude 162.8 - 2.21154  
equal to  $2^{\circ} 42' 48''$ , the difference of longitude easterly.

**CASE VI.** One latitude, course, and difference of longitude, given; to find the other latitude, and distance failed.

**EXAMPLE.** Suppose a ship from the latitude of  $48^{\circ} 50'$  north, fails south  $34^{\circ} 40'$  west, till her difference of longitude is  $2^{\circ} 42'$ : Required the latitude come to, and the distance failed.

**GEOMETRICALLY.** 1. Draw AE ( $n^{\circ} 18.$ ) to represent the meridian of the ship in the first latitude, and make the angle EAC equal to  $34^{\circ} 40'$ , the angle of the course; then draw FC parallel to AE, at the distance of 164 the minutes of difference of longitude, which will meet AC in the point C. From C let fall upon AE the perpendicular CE; then AE will be the enlarged difference of latitude. To find which by calculation, it will be, (by rectangular trigonometry,)

$$T, A : R :: CE : AE,$$

*i. e.* As the tang. of the course  $34^{\circ}, 40'$  9.83984  
is to the radius - - - - - 10.00000  
so is min. of diff. longitude - 164 - 2.21484  
to the enlarged diff. of latitude 237.2 - 2.37500  
and because the ship is failing from a north latitude southerly, therefore

From the merid. parts of }  
the latitude failed from } -  $48^{\circ}, 50'$  3366.9  
take the merid. difference of latitude - 237.2

and there remains - - - - - 3129.7  
the meridional parts of the latitude come to, viz.  $46^{\circ} 09'$ .

Hence for the proper difference of latitude,  
From the latitude failed from - - -  $48^{\circ}, 50'$  N  
take the latitude come to - - - - -  $46^{\circ}, 09'$  N

and there remains - - - - -  $2^{\circ} 41'$   
equal to 161, the minutes of difference of latitude.

2. Set off upon AE the length AD equal to 161 the proper difference of latitude, and thro' D draw DB parallel to CE: then AB will be the direct distance. To find which by calculation, it will be, (by rectangular trigonometry,)

$$R : AD :: \text{Sec. } A : AB.$$

*i. e.* As radius - - - - - 10.00000  
is to the proper diff of latitude - 161 - 2.20683  
so is the secant of the course -  $34^{\circ}, 40'$  10.08488  
to the direct distance - 195.8 - 2.29171

**CASE VII.** One latitude, course, and departure given; to find the other latitude, distance failed, and difference of longitude.

**EXAMPLE.** Suppose a ship fails from the latitude of  $54^{\circ}$



54° 36' north, south 42° 33' east, until she has made of departure 116 miles: Required the latitude she is in, her direct distance failed, and how much she has altered her longitude.

GEOMETRICALLY. 1. Having drawn the meridian AB, (n° 19.) make the angle BAD equal to 42° 33'. Draw FD parallel to AB at the distance of 116, which will meet AD in D. Let fall upon AB the perpendicular DB. Then AB will be the proper difference of latitude, and AD the direct distance: to find which by calculation, first, for the distance AD it will be (by rectangular trigonometry,)

$$S, A : BD :: R : AD.$$

*i. e.* As the sine of the course 42°, 33' - 9.83010  
is to the departure - 116 - 2.06446  
fo is radius - - - 10.00000  
to the direct distance - 171.5 - 2.23436

Then for the proper difference of latitude, it will be, (by rectangular trigonometry,)

$$T, A : BD :: R : AB,$$

*i. e.* as the tang. of the course 42°, 33' 9.96281  
is to the departure - 116 - 2.06446  
fo is radius - - - 10.00000  
to the proper difference of latitude 126.4 2.10165

equal to 2° 6': consequently the ship has come to the latitude of 52° 30' north; and fo the meridional difference of latitude will be 212.2.

2. Produce AB to E, till AE be equal to 212.2; and through E draw EC parallel to BD, meeting AD produced in C; then EC will be the difference of longitude; to find which by calculation, it will be, (by rectangular trigonometry,)

$$R : AE :: T, A : EC.$$

*i. e.* As radius - - - 10.00000  
is to the merid. diff. of latitude 212.2 - 2.32675  
fo is the tang. of the course 42°, 33' 9.96281  
to the merid. diff. of longitude 194.8 - 2.28956  
equal to 3° 14' 48", the difference of longitude easterly.

This might have been found otherwise, thus: because the triangles ACE, ADB, are similar; therefore it will be,

$$AB : BD :: AE : EC.$$

*i. e.* As the proper diff. of latitude 126.4 2.10165  
is to the departure - 116 2.06446  
fo is the enlarged diff. of lat. - 212.2 2.32675  
to merid. diff. of longitude - 194.8 2.28956

CASE VIII. Both latitudes and departure given, to find course, distance, and difference of longitude.

EXAMPLE. Suppose a ship from the latitude of 46° 20' N. fails between south and west, till she has made of departure 126.4 miles; and is then found by observation to be in the latitude of 43° 35' north: Required the course and distance failed, and difference of longitude.

GEOMETRICALLY. Draw AK (n° 20.) to represent the meridian of the ship in her first latitude; set off upon it AC, equal to 165, the proper difference of latitude. Draw BC perpendicular to AC, equal to 126.4 the departure, and join AB. Set off from A, AK equal to 233.3, the enlarged difference of latitude; and through K draw KD parallel to BC, meeting AB produced in D; fo the case is constructed, and DK will be the difference of longitude, AB the distance, and the angle A the course; to find

which,

By CALCULATION:

First, For DC the difference of longitude, it will be,

$$AC : CB :: AK : KD.$$

*i. e.* As the proper diff. of latitude 165 2.21748  
is to the departure - 126.4 2.10175  
fo is the enlarged diff. of latitude 233.3 2.36791  
to min. of diff. longitude - 178.7 2.25218  
equal to 2° 58' 42", the difference of longitude westerly.

Then for the course it will be, (by rectangular trigonometry,)

$$AC : BC :: R : T, A.$$

*i. e.* As the proper diff. of latitude 165 2.21748  
is to departure - 126.4 2.10175  
fo is radius - - - 10.00000  
to the tangent of the course 37°, 27' 9.88427  
which, because the ship fails between south and west, will be south 37°, 27' west, or SW/S 6° 30' westerly.

Lastly, For the distance AB, it will be, (by rectangular trigonometry,)

$$S, A : BC :: R : AB.$$

*i. e.* As the sine of the course 37°, 27' 9.78395  
is to the departure - 126.4 - 2.10175  
fo is radius - - - 10.00000  
to the direct distance - 207.9 - 2.31780

CASE IX. One latitude, distance failed, and departure given; to find the other latitude, difference of longitude, and course.

EXAMPLE. Suppose a ship in the latitude of 48° 33' north, fails between south and east 138 miles, and has then made of departure 112.6: Required the latitude come to, the direct course, and difference of longitude.

GEOMETRICALLY. 1. Draw BD (n° 21.) for the meridian of the ship; and parallel to it draw FE, at the distance of 112.6, the departure. Take 138, the distance, in your compasses, and fixing one point of them in B, with the other cross the line FE in the point E; then join B and E, and from E let fall upon BD the perpendicular ED; fo BD will be the proper difference of latitude, and the angle B will be the course; to find which, by calculation,

First, For the course it will be, (by rectangular trigonometry,)

$$BE : R :: DE : S, B.$$

*i. e.* As the distance - 138 - 2.13988  
is to radius - - - 10.00000  
fo is the departure - 112.6 - 2.05154  
to the sine of the course - 54° 41' - 9.91166  
which, because the ship fails between south and east, will be south 54° 41' east, or SE 0° 41' easterly.

Then for the difference of latitude, it will be, (by rectangular trigonometry,)

$$R : BE :: Co S, B : BD.$$

*i. e.* As radius - - - 10.00000  
is to the distance - 138 - 2.13988  
fo is the co-sine of the course 54° 41' - 9.76200  
to the difference of latitude 79.8 - 1.90188  
equal to 1° 19'. Consequently the ship has come to the latitude of 47° 13'. Hence the meridional difference of latitude will be 117.7.

2dly, Produce B to A, till BA be equal to 117.7; and

**PRACTICE** and through A draw AC parallel to DE, meeting BE produced in C; then AC will be the difference of longitude; to find which by calculation, it will be,

$$BD : DE :: BA : AC.$$

i. e. As the proper diff. of latitude 79.8 1.90180  
is to the departure - 112.6 2.05154  
so is the enlarged diff. of latitude 117.7 2.07078  
to the diff. of longitude - 166.1 2.22044  
equal to  $2^{\circ} 46' 06''$ , the difference of longitude exactly.

10. From what has been said, it will be easy to solve a traverse according to the rules of Mercator's sailing.

**EXAMPLE.** Suppose a ship at the Lizard in the latitude  $50^{\circ} 00'$  north, is bound to the Madera in the latitude of  $32^{\circ} 20'$  north, the difference of longitude tween them being  $11^{\circ} 40'$ , the west end of the Madera lying so much to the westward of the Lizard, and consequently the direct course and distance (by *Case 2. of this Sect.*), is south  $26^{\circ} 15'$  west 1181.9 miles; but by reason of the winds she is forced to sail on the following courses, (allowance being made for lee-way and variation, &c.), viz. SSW 44 miles, S $\frac{1}{2}$ W 36 miles, SW $\frac{1}{2}$ S 56 miles, and S $\frac{1}{2}$ E 28 miles: Required the latitude the ship is in, her bearing and distance from the Lizard, and her direct course and distance from the Madera, at the end of these courses.

The geometrical construction of this traverse is performed by laying down the two ports according to construction of *Case 2. of this Section*, and the several courses and distances according to *Case 3.* by which we have the following solution by calculation.

1. Course SSW, distance 44 miles.

For difference of latitude.

As radius - - - - - 10.00000  
is to the distance - 44 - 1.64345  
so is the co-fine of the course  $22^{\circ} 30'$  - 9.96562  
to the difference of latitude 40.65 1.60907

and since the course is southerly, therefore the latitude come to will be  $49^{\circ} 20'$  north, and consequently the meridional difference of latitude will be  $61.8$ .  
Then,

For difference of longitude.

As radius - - - - - 10.00000  
is to the enlarged diff. of lat. 61.8 - 1.79099  
so is the tang. of the course  $22^{\circ} 30'$  - 9.61722  
to min. of diff. of longitude 25.6 - 1.40821

2. Course S $\frac{1}{2}$ W  $\frac{1}{2}$  west, distance 36 miles.

For difference of latitude.

As radius - - - - - 10.00000  
is to the distance - 36 - 1.55630  
so is the co-fine of the course  $16^{\circ} 52'$  9.98090  
to the difference of latitude 34.46 - 1.53720

and since the course is southerly, therefore the latitude come to will be  $48^{\circ} 45'$ . Hence the meridional difference of latitude will be 53.4. Then,

For difference of longitude.

As radius - - - - - 10.00000  
is to the enlarged diff. of lat. 53.4 - 1.72754  
so is the tang. of the course  $16^{\circ} 52'$  9.48171  
to the difference of longitude 16.19 1.20925

3. Course SW $\frac{1}{2}$ S, distance 56 miles.

For difference of latitude.

As radius - - - - - 10.00000  
is to the distance - 56 - 1.74819

so is the co-fine of the course  $33^{\circ} 45'$  - 9.91985  
to the difference of latitude 46.56 - 1.66804  
consequently the latitude come to is  $47^{\circ} 59'$ ; and therefore the enlarged difference of latitude will be 69.2.  
Then,

For difference of longitude.

As radius - - - - - 10.00000  
is to the enlarged diff. of lat. 69.2 - 1.84011  
so is the tang. of the course  $33^{\circ} 45'$  9.82489  
to the difference of longitude 46.24 1.66500

4. Course S $\frac{1}{2}$ E, distance 28 miles.

For difference of latitude.

As radius - - - - - 10.00000  
is to the distance - 28 - 1.44716  
so is the co-fine of the course  $11^{\circ} 15'$  9.99157  
to the difference of latitude 27.46 1.43873

consequently the latitude come to will be  $47^{\circ} 31'$ ; and hence the meridional difference of latitude will be 43.2.  
Then,

For difference of longitude.

As radius - - - - - 10.00000  
is to the enlarged diff. of lat. 43.2 - 1.63548  
so is the tang. of the course  $11^{\circ} 15'$  9.29866  
to the diff. of longitude 8.59 - 0.93414

Now these several courses and distances, together with the difference of latitude and longitude belonging to each of them, being set down in their proper columns in the *Traverse Table*, will stand as follows.

Courses.	Distances.	Diff. of Lat.				Diff. of Longit.
		N.	S.	E.	W.	
SSW	44		40.65		25.6	
S $\frac{1}{2}$ W $\frac{1}{2}$	36		34.46		16.16	
SW $\frac{1}{2}$ S	56		46.56		49.24	
S $\frac{1}{2}$ E	28		27.46	8.56		
Diff. of Lat.		149.13	8.59		88.03	
					0.59	
					Diff. of Long. 79.44	

Hence it is plain that the ship has made of southing 149.13 minutes, and consequently has come to the latitude of  $47^{\circ} 31'$  north, and so the meridional difference of latitude between that and her first latitude will be 226.1: And since she has made of difference of longitude 79.44 minutes westerly; therefore, for the direct course and distance between the Lizard and the ship, it will be, (by *Case 2. of this Section*).

For the direct course.

As the merid. diff. of latitude 226.1 - 2.35430  
is to radius - - - - - 10.00000  
so is the difference of longitude 79.44 - 1.90004  
to the tang. of the course -  $19^{\circ} 22'$  - 9.54593  
which, because the difference of latitude is southerly, and the difference of longitude westerly, will be south  $19^{\circ} 22'$  west, or S $\frac{1}{2}$ W  $8^{\circ} 7'$  westerly. Then,

For the direct distance.

As radius - - - - - 10.00000  
is to the proper diff. of lat. 149.13 - 2.17349  
so is the secant of the course  $19^{\circ} 22'$  - 10.02530

PRACTICE To the direct distance - 158 - 2.19879  
 From the latitude the ship is in - 47°, 31' N  
 subtract the lat. of the Madera - 32, 20 N

and there remains - 15, 11  
 equal to 911 minutes, the proper difference of latitude between the ship and the Madera.

Again, from the merid. parts answering to the latitude the ship is in } 3248.4  
 Take the meridional parts answering to }  
 the latitude of the Madera } 2052.0

and there remains - 1196.4  
 the enlarged difference of latitude between the ship and the Madera.

Also, from the diff. of long. between } 11°, 40' W  
 the Lizard and the Madera }  
 Take the difference of lon. between } 1, 19, 44 W  
 the Lizard and the ship }

and there remains - 10, 20, 25 W  
 equal to 620.56 min. of difference of longitude between the ship and the Madera westerly.

Then for the direct course and distance between the ship and the Madera, it will be,

For the direct course:

As the merid. diff. of latitude 1196.4 3 07788  
 is to radius 10.00000  
 so is the difference of longitude 620.56 2.79278  
 to the tang. of the course 27°, 25' 9 71493

For the direct distance:

As radius 10.00000  
 is to the proper diff. of latitude 911 2.95952  
 so is the secant of the course 27°, 25' 10.05174  
 to the direct distance 1027 3.01126

11. It is very common in working a day's reckoning at sea, to find the difference of latitude and departure to each course and distance; and adding all the departures together, and all the differences of latitudes for the whole departure, and difference of latitude made good that day, from thence (by *Case 8. of this Section*) to find the difference of longitude, &c. made good that day. Now that this method is false, will evidently appear, if we consider that the same departure, reckoned on two different parallels, will give unequal differences of longitude; and consequently, when several departures are compounded together and reckoned on the same parallel, the difference of longitude resulting from that cannot be the same with the sum of the differences of longitude resulting from the several departures on different parallels; and therefore we have chosen, in the last *example of a traverse*, to find the difference of longitude answering to each particular course and distance, the sum of which must be the true difference of longitude made good by the ship on these several courses and distances.

12. We shewed, at *Art. 3. of this Section*, how to construct a *Mercator's chart*; and now we shall proceed to its several uses, contained in the following problems.

PROB. I. Let it be required to lay down a place upon the chart, its latitude, and the difference of longitude between it and some known place upon the chart being given.

EXAMPLE. Let the known place be the Lizard by VOL. VII.

PRACTICE ing on the parallel of 50° 00' north, and the place to be laid down St Katharine's on the east coast of America, differing in longitude from the Lizard 42° 36', lying so much to the westward of it.

Let L represent the Lizard on the chart, (see N° 12.) lying on the parallel of 50° 00' north, its meridian. Set off AE from E upon the equator EQ, 42° 36', towards Q, which will reach from E to F. Through F draw the meridian FG, and this will be the meridian of St Katharine's; then let off from Q to H upon the graduated meridian QB, 28 degrees; and thro' H draw the parallel of latitude HM, which will meet the former meridian in K, the place upon the chart required.

PROB. II. Given two places upon the chart, to find their difference of latitude and difference of longitude.

Through the two places draw parallels of latitude; then the distance between these parallels, numbered in degrees and minutes upon the graduated meridian, will be the difference of latitude required; and thro' the two places drawing meridians, the distance between these, counted in degrees and minutes on the equator or any graduated parallel, will be the difference of longitude required.

PROB. III. To find the bearing of one place from another upon the chart.

EXAMPLE. Required the bearing of St Katharine's at K (see N° 12.) from the Lizard at L.

Draw the meridian of the Lizard AE, and join K and L with the right line KL; then by the line of chords measuring the angle KLE, and with that entering the tables, we shall have the thing required.

This may also be done, by having compasses drawn on the chart, (suppose at two of its corners); then lay the edge of a ruler over the two places, and let fall a perpendicular, or take the nearest distance from the centre of the compass next the first place, to the ruler's edge; then with this distance in your compasses, slide them along by the ruler's edge, keeping one foot of them close to the ruler, and the other as near as you can judge perpendicular to it, which will describe the rhumb required.

PROB. IV. To find the distance between two given places upon the chart.

This problem admits of four cases, according to the situation of the two places with respect to one another.

CASE I. When the given places lie both upon the equator.

In this case their distance is found by converting the degrees of difference of longitude intercepted between them into minutes.

CASE II. When the two places lie both on the same meridian.

Draw the parallels of those places; and the degrees upon the graduated meridian, intercepted between those parallels, reduced to minutes, give the distance required.

CASE III. When the two places lie on the same parallel.

EXAMPLE. Required to find the distance between the points K and N (see N° 12.) both lying on the parallel of 28° 00' north. Take from your scale the

**PRACTICE** chord of  $60^\circ$  or radius in your compasses, and with that extent on KN as a base make the isosceles triangle KPN; then take from the line of sines the co-sine of the latitude, or sine of  $72^\circ$ , and set that off from P to S and T. Join S and T with the right line ST, and that applied to the graduated equator will give the degrees and minutes upon it equal to the distance; which, converted into minutes, will be the distance required.

The reason of this is evident from the section of *Parallel Sailing*: for it has been there demonstrated, that radius is to the co-sine of any parallel, as the length of any arch on the equator, to the length of the same arch on that parallel. Now in this chart KN is the distance of the meridians of the two places K and N upon the equator; and since, in the triangle PNK, ST is the parallel to KN, therefore PN : PT :: NK : TS. Consequently TS will be the distance of the two places K and N upon the parallel of  $28^\circ$ .

If the parallel the two places lie on be not far from the equator, and they not far asunder; then their distance may be found thus: Take the distance between them in your compasses, and apply that to the graduated meridian, so as the one foot may be as many minutes above as the other is below the given parallel; and the degrees and minutes intercepted, reduced to minutes, will give the distance.

Or it may also be found thus: Take the length of a degree on the meridian at the given parallel, and turn that over on the parallel from the one place to the other, as oft as you can; then as oft as that extent is contained between the places, so many times 60 miles will be contained in the distance between them.

**CASE IV.** When the places differ both in longitude and latitude.

**EXAMPLE.** Suppose it were required to find the distance between the two places *a* and *e* upon the chart. By

**Prob. II.** Find the difference of latitude between them; and take that in your compasses from the graduated equator, which set off on the meridian of *a*, from *a* to *b*; then thro' *b* draw *bc* parallel to *de*; and taking *ac* in your compasses, apply it to the graduated equator, and it will shew the degrees and minutes contained in the distance required, which multiplied by 60 will give the miles of distance.

The reason of this is evident from *Art. 6. of this Section*: for it is plain *a d* is the enlarged difference of latitude, and *ab* the proper; consequently *ac* the enlarged distance, and *ac* the proper.

**Prob. V.** To lay down a place upon the chart, its latitude and bearing from some known place upon the chart being known, or (which is the same) having the course and difference of latitude that a ship has made, to lay down the running of the ship, and find her place upon the chart.

**EXAMPLE.** A ship from the Lizard in the latitude of  $50^\circ 00'$  north, sails SSW till she has differed her latitude  $36^\circ 40'$ . Required her place upon the chart.

Count from the Lizard at L, on the graduated meridian downwards (because the course is southerly)  $36^\circ 40'$  to *g*; through which draw a parallel of latitude, which will be the parallel the ship is in; then from L draw a SSW line L*f*, cutting the former pa-

rallel in *f*, and this will be the ship's place upon the **PRACTICE** chart.

**Prob. VI.** One latitude, course, and distance, failed, given; to lay down the running of the ship, and find her place upon the chart.

**EXAMPLE.** Suppose a ship at *a* in the latitude of  $20^\circ 00'$  north, sails north  $37^\circ 20'$ , east 191 miles: Required the ship's place upon the chart.

Having drawn the meridian and parallel of the place *a*, set off the rhumb-line *ac*, making with *ab* an angle of  $37^\circ 20'$ , and upon it set off 191 from *a* to *c*; thro' *c* draw the parallel *cb*; and taking *ab* in your compasses, apply it to the graduated equator, and observe the number of degrees it contains; then count the same number of degrees on the graduated meridian from C to *b*, and through *b* draw the parallel *be*, which will cut *ac* produced in the point *e*, the ship's place required.

**Prob. VII.** Both latitudes and distance failed, given; to find the ship's place upon the chart.

**EXAMPLE.** Suppose a ship sails from *a*, in the latitude of  $20^\circ 00'$  north, between north and east 191 miles, and is then in the latitude of  $45^\circ 00'$  north: Required the ship's place upon the chart.

Draw *de* the parallel of  $45^\circ$ , and set off upon the meridian of *a* upwards, *ab* equal to the proper difference of latitude taken from the equator or graduated parallel. Through *b* draw *bc* parallel to *de*; then with 191 in your compasses, fixing one foot of them in *a*, with the other cross *be* in *c*. Join *a* in *c* with the right line *ac*; which produced will meet *de* in *e*, the ship's place required.

**Prob. VIII.** One latitude, course, and difference of longitude, given; to find the ship's place upon the chart.

**EXAMPLE.** Suppose a ship from the Lizard in the latitude of  $50^\circ 00'$  north, sails SW $\frac{1}{2}$ W, till her difference of longitude is  $42^\circ 36'$ : Required the ship's place upon the chart.

Having drawn AE the meridian of the Lizard at L, count from E to F upon the equator  $42^\circ 36'$ ; and through F draw the meridian EG; then from L draw the SW $\frac{1}{2}$ W line LK, and where this meets FG, as at K, will be the ship's place required.

**Prob. IX.** One latitude, course, and departure, given; to find the ship's place upon the chart.

**EXAMPLE.** Suppose a ship at *a* in the latitude of  $20^\circ 00'$  north, sails north  $37^\circ 20'$  east, till she has made of departure 116 miles: Required the ship's place upon the chart.

Having drawn the meridian of *a*, at the distance of 116, draw parallel to it the meridian *kl*. Draw the rhumb-line *ac*, which will meet *kl* in some point *c*; then through *c* draw the parallel *cb*, and *ab* will be the proper difference of latitude, and *bc* the departure. Take *ab* in your compasses, and apply it to the equator or graduated parallel; then observe the number of degrees it contains, and count so many on the graduated meridian from C upwards to *b*. Through *b* draw the parallel *be*, which will meet *ac* produced in some point *e*, which is the ship's place upon the chart.

**Prob. X.** One latitude, distance, and departure, given; to find the ship's place upon the chart.

**EXAMPLE.** Suppose a ship at *a* in the latitude of  $20^\circ 00'$  north, sails 191 miles between north and east, and then

**PRACTICE** then is found to have made of departure 116 miles: Required the ship's place upon the chart.

Having drawn the meridian and parallel of the place *a*, set off upon the parallel *am* equal to 116, and thro' *m* draw the meridian *kl*. Take the given distance 191 in your compasses; setting one foot of them in *a*, with the other cross *kl* in *c*. Join *ac*, and through *c* draw the parallel *cb*; so *cb* will be the departure, and *ab* the proper difference of latitude; then proceeding with this, as in the foregoing problem, you will find the ship's place to be *e*.

**PROB. XI.** The latitude sailed from, difference of latitude, and departure, given; to find the ship's place upon the chart.

**EXAMPLE.** Suppose a ship from *a* in the latitude of  $20^{\circ} 00'$  north, sails between north and east, till she be in the latitude of  $45^{\circ} 00'$  north, and is then found to have made of departure 116 miles: Required the ship's place upon the chart.

Having drawn the meridian of *a*, set off upon it, from *a* to *b*, 25 degrees, (taken from the equator or graduated parallel), the proper difference of latitude; then through *b* draw the parallel *bc*, and make *bc* equal to 116 the departure, and join *ac*. Count from the parallel of *a* on the graduated meridian upwards to *b* 25 degrees, and through *b* draw the parallel *be*, which will meet *ac* produced in some point *e*, and this will be the place of the ship required.

13. In the section of *Plane Sailing*, it is plain, that the terms *meridional distance*, *departure*, and *difference of longitude*, were synonymous, constantly signifying the same thing; which evidently followed from the supposition of the earth's surface being projected on a plane in which the meridians were made parallel, and the degrees of latitude equal to one another and to those of the equator. But since it has been demonstrated (in this section) that if, in the projection of the earth's surface upon a plane, the meridians be made parallel, the degrees of latitude must be unequal, still increasing the nearer they come to the pole; it follows, that these terms must denote lines really different from one another.

### § 6. Of Oblique Sailing.

THE questions that may be proposed on this head being innumerable, we shall only give a few of the most useful.

**PROB. I.** Coasting along the shore, I saw a cape bear from me NNE; then I stood away NW $\frac{1}{2}$ W 20 miles, and I observed the same cape to bear from me NE $\frac{1}{2}$ E: Required the distance of the ship from the cape at each station.

**PLATE CCIII.** GEOMETRICALLY. Draw the circle NWSE ( $N^{\circ} 22.$ ) to represent the compass, NS the meridian, and WE the east and west line, and let C be the place of the ship in her first station; then from C set off upon the NW $\frac{1}{2}$ W line, CA 20 miles, and A will be the place of the ship in her second station.

From C draw the NNE line CB, and from A draw AB parallel to the NE $\frac{1}{2}$ E line CD, which will meet CB in B the place of the cape, and CB will be the distance of it from the ship in its first station, and AB the distance in the second; to find which,

By CALCULATION;

In the triangle ABC are given AC, equal to 20

1

miles; the angle ACB, equal to  $78^{\circ} 45'$ , the distance between the NNE and NW $\frac{1}{2}$ W lines; also the angle ABC, equal to BCD, equal to  $33^{\circ} 45'$ , the distance between the NNE and NE $\frac{1}{2}$ E lines; and consequently the angle A, equal to  $67^{\circ} 30'$ .

Hence for CB, the distance of the cape from the ship in her first station, it will be (by oblique trigonometry)

S. ABC : AC :: S. BAC : CB,  
*i. e.* As the sine of the angle B  $33^{\circ} 45'$  - 9.74473  
 is to the distance run AC - 20 - - 1.30103  
 so is the sine of BAC - 67, 30 - 9.96562  
 to CB - - - 33.26 - 1.52191  
 the distance of the cape from the ship at the first station. Then for AB, it will be, by oblique trigonometry,

S. ABC : AC :: S. ACB : AB.  
*i. e.* as the sine of B - 33, 45' - 9.74474  
 is to AC - - - 20 - - 1.30103  
 so is the sine of C - 78 - 45 - 9.99157  
 to AB - - - 35.31 - 1.54786  
 the distance of the ship from the cape at her second station.

**PROB. II.** Coasting along the shore, I saw two headlands; the first bore from me NE $\frac{1}{2}$ E 17 miles, the other SSW miles: Required the bearing and distance of these headlands from one another.

GEOMETRICALLY. Having drawn the compass NWSE ( $N^{\circ} 23.$ ) let C represent the place of the ship; set off upon the NE $\frac{1}{2}$ E line CA 17 miles from C to A, and upon the SSW line CB 20 miles from C to B, and join AB: then A will be the first headland, and B the second; also AB will be their distance, and the angle A will be the bearing from the NE $\frac{1}{2}$ N line: to find which,

By CALCULATION;

In the triangle ACB are given, AC 17, CB 20, and the angle ACB equal to  $101^{\circ} 15'$ , the distance between the NE $\frac{1}{2}$ E and SSW lines. Hence (by oblique angular trigonometry) it will be  
 As the sum of the sides AC and CB - 37 1.56820  
 is to their difference - - - 3 0.47712  
 so is the tang. of  $\frac{1}{2}$  the sum } - 39, 22 $\frac{1}{2}$  9.91417  
 of the angles A and B }  
 to the tang. of half their diff. - 3, 49 8.82309  
 consequently the angle A will be  $43^{\circ} 11'$ , and the angle B  $35^{\circ} 34'$ ; also the bearing of B from A will be S $\frac{1}{2}$ W  $1^{\circ} 49'$  westerly, and the bearing of A from B will be N $\frac{1}{2}$ E  $1^{\circ} 49'$  easterly.

Then for the distance AB, it will be, (by oblique angular trigonometry),

S. A : CB :: S. C : AB.  
*i. e.* As the sine of A - 43, 11' - 9.83527  
 is to CB - - - 20 - - 1.30103  
 so is the sine of C - 101, 15 - 9.99157  
 to AB - - - 28.67 - 1.45733  
 the distance between the two headlands.

**PROB. III.** Coasting along the shore, I saw two headlands; the first bore from me NW $\frac{1}{2}$ N, and the second NNE; then standing away EN $\frac{1}{2}$ N northerly 20 miles, I found the first bore from me WNW $\frac{1}{2}$  westerly, and the second N $\frac{1}{2}$ W $\frac{1}{2}$  westerly: Required the bearing and distance of these two headlands.

GEOMETRICALLY. Having drawn the compass NWSE ( $N^{\circ} 24.$ ) let C represent the first place of the

30 G 2

ship;

ship; from which draw the NW½N line CB, and the NNE line CD, also the E½N ½ N line CA, which make equal to 20. From A draw AB parallel to the WNW ½ W line, and AD parallel to the N½W ½ W meeting the two first lines in the points B and D; then B will be the first and D the second headlands. Join the points B and D, and BD will be the distance between them, and the angle CDB the bearing from the NNE line: to find which,

By CALCULATION;

1. In the triangle ABC are given the angle BCA, equal to  $104^{\circ} 04'$ , the distance between the NW½N line, and the ENE½E line; the angle BAC, equal to  $36^{\circ} 34'$ , the distance between the WSW½W line and the WNW ½ W line; the angle ABC equal to  $39^{\circ} 22'$ , the distance between the ESE½E line; and the SW½S line, also the side CA equal to 20 miles: whence for CB, it will be (by oblique trigonometry)

As the sine of CBA	-	$39^{\circ}, 22'$	-	9.80228
is to AC	-	20	-	1.30103
so is the sine of CAB	-	$36^{\circ}, 34'$	-	9.77507
to CB	-	18.79	-	1.27382

the distance between the first headland and the ship in her first station.

2. In the triangle ACD, are given the angle ACD, equal to  $47^{\circ} 49'$ , the distance between the ENE½E line, and the NNE line; the angle CAD, equal to  $92^{\circ} 49'$ , the distance between the WSW½W line; and the N½W ½ W line, the angle CDA equal to  $39^{\circ} 22'$ , the distance between the SSW line and the SE½E line; also the leg CA equal to 20.

Hence for CD, it will be (by oblique trigonometry)

As the sine CAD	-	$39^{\circ}, 22'$	-	9.80228
is to AC	-	20	-	1.30103
so is the sine of CAD	-	$92^{\circ}, 34'$	-	9.99960
to CD	-	31.5	-	1.49835

the distance between the second headland and the ship in her first station.

3. In the triangle BCD are given BC 18.79, CD 31.5, and the angle BCD equal to  $56^{\circ} 15'$ , the distance between the NW½N line and the NNE line.

Hence for the angle CDB, it will be (by oblique trigonometry)

As the sum of the sides	-	50.29	-	1.70148
is to the difference of sides	-	12.71	-	1.10415
so is tangent of ½ sum of				
the unknown angles	} 61°, 51'	-	10.27189	
to tang. of half their diff.	-	$25^{\circ}, 18'$	-	9.67458

consequently the angle CBD is  $87^{\circ} 10'$ , and the angle CDB  $36^{\circ} 35'$ . Hence the bearing of the first headland from the second will be S  $59^{\circ} 8'$ , W or SW½W½W nearly; and for the distance between them, it will be,

As the sine of BDC	-	$36^{\circ}, 35'$	-	9.77524
is to BC	-	18.79	-	1.27382
so is the sine of BCD	-	$56^{\circ}, 15'$	-	9.91985
to BD	-	26.21	-	1.41843

the distance between the two headlands.  
This, and the first problem, are of great use in drawing the plot of any harbour, or laying down any sea-coast.

Suppose a ship that makes her way good within  $6\frac{1}{2}$  points of the wind, at north, is bound to a port bearing east 86 miles distance from her: Required the

course and distance upon each tack, to gain the intended port.

GEOMETRICALLY. Having drawn the compass NE SW, ( $N^{\circ} 25'$ .) let C represent the ship's place, and set off upon the east line CA 86 miles, so A will be the intended port. Draw CD and CB on each side of the north line at  $6\frac{1}{2}$  points distance from it, and through A draw AB parallel to CD meeting CB in B; then the ENE½E line CB, will be the course of the ship upon the starboard tack, and CB its distance on that tack; also the ESE½E line Ab, will be the course on the larboard tack, and BA the distance on that tack: to find which,

By CALCULATION;

In the triangle ABC are given the angle ACB, equal to  $16^{\circ} 53'$ , the distance between the east and ENE½E line; the angle CBA, equal to  $146^{\circ} 14'$ , the distance between the ENE½E and the WNW½W lines; the angle BAC equal to  $16^{\circ} 53'$ , the distance between the east and ESE½E lines; also AC 86 miles.

Hence, since the angle A and C are equal, the legs CB and BA will likewise be equal; to find either of which (suppose CB) it will be (by oblique angled trigonometry)

As the sine of B	-	$146^{\circ}, 14'$	-	9.74493
is to AC	-	86	-	1.93450
so is the sine of A	-	$16^{\circ}, 53'$	-	9.46303
to CB	-	44.94	-	1.65260

the distance the ship must sail on each tack.

There is a great variety of useful questions of this nature that may be proposed; but the nature of them being better understood by practice at sea, we shall leave them, and go on to Great Circle Sailing.

### § 6. Great Circle Sailing.

A GREAT many cases might be proposed in this kind of sailing; but as they serve rather for exercises in the solution of spheric triangles than for any real use towards the navigating of a ship, we shall only give the solution of one problem, as being the most generally useful.

PROB. Given the latitudes and longitudes of two places on the earth: Required the nearest distance on the surface, together with the angles of position (or that which a great circle, passing over both places, makes with the meridian of one of them) from either place to the other.

CASE I. When both places lie under the same meridian, their difference of latitude shews their nearest distance.

CASE II. When the two places lie under the equator, their distance is equal to the difference of longitude between them.

CASE III. When the places lie under the same parallel of latitude.

EXAMPLE. What is the least distance between St Mary's in Lat.  $37^{\circ} 00'$  N. Long.  $25^{\circ} 0'$  W. and Cape Henry, in Lat.  $37^{\circ} 00'$  Long.  $76^{\circ} 23'$  west?

Describe a circle PESQ representing the meridian of one of the places; suppose of the eastern one, as Plate CCI. St Mary's; draw the line EQ representing the equator, and at right angles to it draw the line PS, for the axis of the earth, the extremity of which, P, is the north pole, and S the south pole; and on this circle lay off from P to A the complement of the lati-

**PRACTICE** latitude of St Mary's, the eastern place. On the equator, from Q to C, lay off the difference of longitude between the two places; and through the points P, C, S, describe a circle, which will be the meridian of the other place Cape Henry; on which lay from P to B the co-latitude of this place, which is done by describing the arc *Az* about the pole P according to the rules of projection, at the distance of the co-latitude. Through the points *ABD* describe a great circle; then will A represent St Mary's, and B Cape Henry; PA and PB are their co-latitudes; the angle APB, which is measured by the arc *QC*, is the difference of longitude; the arc AB is the nearest distance of these places; the angle PAB is the angle of position from A to B; and the angle PBA is the angle of position from B to A. The arc AB, and the angle PAB or PBA, may be measured according to the rules laid down under the article PROJECTION. Now, the places having the same latitude, PA is equal to PB, and the angles PAB and PBA are likewise equal. Therefore if the arc PI be described, making the angle API =  $25^{\circ} 41\frac{1}{2}'$ , the half of the difference of longitude; PI will be perpendicular to AB, and bisect it. And in the triangle AIP, right-angled at I, there will be given the hypotenuse AP =  $53^{\circ} 00'$  the angle API =  $25^{\circ} 41\frac{1}{2}'$ ; to find the leg AI = half the distance sought, and the angle PAI = the angle of position. Then, for the distance: As radius is to the sine of the hypotenuse PA, so is the sine of the given angle API to the sine of the leg AI. Or,

As radius	= $90^{\circ} 00'$	-	10.00000
To cof. lat.	= $37^{\circ} 00'$	-	9.90235
So sine $\frac{1}{2}$ diff. long.	= $25^{\circ} 41\frac{1}{2}'$	-	9.63702
To sine $\frac{1}{2}$ diff.	= $20^{\circ} 75\frac{1}{2}'$	-	9.53937

which doubled, gives  $40^{\circ} 31'$  for the distance; and this distance, reduced to nautical miles, is 2431; less by 31 than that given by parallel sailing.—For the angle of position, As radius is to the co-sine of the hypotenuse PA, so is the tangent of the given angle API to the co-tangent of the angle A. Or,

As radius	= $90^{\circ} 00'$	-	10.00000
To sine lat.	= $37^{\circ} 00'$	-	9.77946
So tang. $\frac{1}{2}$ dif. long.	= $25^{\circ} 41\frac{1}{2}'$	-	9.68222
To co-tang. ang. posit.	= $73^{\circ} 51'$	-	9.46168

Hence it appears, that to sail from A to B, or from B to A, the ship must first steer N.  $73^{\circ} 51'$  W. or E. and then gradually increase her course till she comes to I, where it will be due west or east; and from thence the course is to be gradually diminished again till she comes to the other port, where it will be  $73^{\circ} 51'$ , the same as she set out with.

**CASE IV.** When one place has latitude, and the other has none.

**EXAMPLE.** What is the nearest distance between the island of St Thomas, in lat.  $0^{\circ} 00'$ , and long.  $1^{\circ} 2'$  The co-latitude of St Julian is  $41^{\circ} 09'$ ; and the difference of longitude between the two places is  $66^{\circ} 10'$ .—Let the point A (plate CCL. fig. 7.) be St Thomas, and P and S the north and south poles. Make AC, the measure of the angle ASC, equal to  $66^{\circ} 10'$  the difference of longitude. Then, as Port St Julian is in south latitude, about S the south pole at the distance of Julian's co-latitude, describe the arc *as*, cutting SCP, the meridian of Julian in B, through

the points A, B, E, a great circle being described, the arc AB is the distance sought. The distances and angles may now be measured according to the rules of projection, or it falls under a case in spheric trigonometry: for, in the quadrantal triangle ASB, there are given the co-latitude of St Thomas or AS =  $90^{\circ} 00'$ ; the co-latitude of St Julian, or SB =  $41^{\circ} 09'$ ; the difference of longitude, or the angle ASB =  $66^{\circ} 10'$ , from whence all the rest may be found. Or, in the supplemental triangle, ACB, right-angled at C, there is given the latitude of St Julian's, or the leg CB =  $48^{\circ} 51'$ ; the difference of longitude, or the leg CA =  $66^{\circ} 10'$ , whence the rest may easily be found; and hence it will appear, that a ship sailing from the island of St Thomas must first shape her course south  $51^{\circ} 22'$  W; and then, by constantly altering her course towards the west, so as to arrive at Port St Julian on a course S.  $71^{\circ} 36'$  W. she will have sailed the shortest distance between these places.

**CASE V.** When the latitudes of the given places are both north, or both south.

**EXAMPLE.** What is the nearest distance between the Lizard and the island of Bermudas, and also the angles of position?—The difference of longitude of the two places is  $58^{\circ} 11'$ .

Make PA (Plate CCL. fig. 8.) =  $57^{\circ} 25'$ , the co-latitude of Bermudas; Pa =  $40^{\circ} 03'$ , the co-latitude of the Lizard; and with the tangent of Pa describe the arc *aa*. With the secant of  $58^{\circ} 11'$ , the difference of longitude, describe arcs from P and S, which give the centre of the circle PCS the meridian of the Lizard; its intersection with *aa* gives B, the place of the Lizard. The arcs of the circle and angles may be measured by spheric trigonometry as before. Had the eastern place, the Lizard, been put upon the primitive circle, the great circle AB would have been difficult to describe; and therefore the western place was put upon it, it being a matter of indifference which of the places are so taken.

**CASE VI.** When one of the given places has north latitude, and the other has south latitude.

**EXAMPLE.** What is the nearest distance from the island of St Helena to the island of Bermudas, and also the angles of position at each place; the difference of longitude between the two being  $5^{\circ} 43'$ ?

Make QA (fig. 9.) =  $15^{\circ} 55'$ , the lat. of St Helena; describe the arc *aa* about P, with the tangent of Pa =  $57^{\circ} 25'$ , the co-latitude of Bermudas. Arcs described from P, S, with the secant of  $5^{\circ} 43'$ , the difference of longitude, will give the centre of the circle PCS, the meridian of Bermudas; and its intersection B with *aa*, is the place of Bermudas. Describe a great circle through A, B, D; the intercepted arc AB is the distance sought; and the angles PAB, ABS, are the positions required, which must be measured according to the rules of spheric trigonometry. From the solutions of these triangles it will appear, that when a ship sails from St Helena to Bermudas on the arc of a great circle, the most first shape her course N.  $48^{\circ} 00'$  W. and gradually alter it from the north towards the west, so as to arrive at Bermudas on a course N.  $50^{\circ} 01'$  W. after having run  $73^{\circ} 26'$ , or 4406 miles. The course found by Mercator's sailing is N.  $48^{\circ} 45'$  W. and the distance is 4414 miles.—By this it ap-  
pears

**PRACTICE** appears, that when the places are one in N. latitude, and the other in S. latitude; neither of them being very far from the equator, there is but a small difference between the results found by Mercator's and great circle sailing: for, near the equator, the rhumb-lines do not differ much from great circles.

From the solution of the foregoing cases, it is plain, that to sail on the arc of a great circle, the ship must continually alter her course. But as this is a difficulty too great to be admitted into the practice of navigation, it has been thought sufficiently exact to effect this business by a kind of approximation, founded upon this principle, that, in small arcs, the difference between the arc and its tangent is so little, that they may be taken one for the other in any nautical operations. Upon this principle, the great circles of the earth are supposed to be made up of short right lines, each of which is a segment of a rhumb-line. And on this supposition the solution of the following problem is founded.

Having given the latitudes and longitudes of the places sailed from, and bound to; to find the successive latitudes on the arc of a great circle in those places where the alteration in longitude shall be a given quantity; together with the courses and distances between those places.

1. Find the angle of position at each place, and their distance by one of the preceding fix cases.

2. Find the greatest latitude the great circle runs through; that is, find the perpendicular from the pole to that circle; and also find the several angles at the pole, made by the given alterations of longitude between this perpendicular and the successive meridians come to.

3. With this perpendicular, and the polar angles severally find as many corresponding latitudes, by saying:

As rad. : tan. greatest lat. :: cof. 1 polar ang. : tan. 1 lat.  
 : : cof. 2 polar ang. : tan. 2 lat.  
 Cc. Cc.

In the triangle PIB.  
 Given PB = 53° 00'  
 the angle PBI = 73 09  
 To find PI.

4. Having the several latitudes passed thro', and the difference of longitude between each, find, by Mercator's sailing, the courses and distances between those latitudes.

And these are the several courses and distances the ship must run to keep nearly on the arc of a great circle.

The smaller the alterations in longitude are taken, the nearer will this method approach the truth; but it is sufficient to compute to every five degrees of difference of longitude, the length of an arc of five degrees differing from its chord or tangent only by 0.0002.

**EXAMPLE.** A ship being bound from a place in lat. 37° 00' N. lon. 22° 56' W. to a place in the same lat. and in lon. 76° 23' W. it is proposed she shall sail as near the arc of a great circle as she can, by altering her course at every five degrees difference of longitude: Required the latitude at each time of altering the course, and also the courses and distances between those several latitudes.

Place sailed from lat. is 37° 00' N. the long. 22° 56' W.  
 Place bound to lat. is 37 00 N. the long. 76 23 W.

The diff. of long. 53 27

The figure being described, and the computation Plate CCI, made, the distance BA is found to be 42° 06', and fig. 10. the angle A or the angle B=73° 09', the angle of position.

Now the triangle APB, being isosceles, the perpendicular PI falls in the middle of AB; and the latitudes, courses, and distances, being known in running the half BI, those in the half IA will also be known.

Let the points a, b, c, d, &c. be the places arrived at on each alteration of five degrees of longitude: then will the arcs Pa, Pb, Pc, Pd, &c. be the respective co-latitudes of those places, and are the hypotenuses of the right-angled spheric triangles PIa, PIb, PIc, PId, &c.

As rad.	= 90° 00'	10.00000
To sin. PB	= 53 00	9.90235
So sin. the ang. B	= 73 09	9.98094
To sin. PI	= 49 51	9.88329

Now the angle IPB =  $(\frac{53^\circ 27'}{2})$  26° 43½'; the angle IPA=21° 43½'; the angle IPb=16° 43½'; the angle IPc = 11° 43½'; the angle IPd=6° 43½', are the several polar angles.

Then rad.	= 90° 00'	10.00000	10.00000	10.00000	10.00000
To co-tang. PI	= 49 51	9.92612	9.92612	9.92612	9.92612
So co-sine polar angle		9.96800	9.98123	9.99084	9.99700
To tang. lat.		9.89412	9.90735	9.91696	9.92312

Which are 38° 05' 38° 56' 39° 33' 39° 57'

The degrees and min. set over each column, are the polar angles used in that proportion, and the corresponding latitudes stand at bottom.

The first term of these proportions being radius, and the second term constant, the operations may be very

expeditiously performed thus.

On a slip of paper let the log. of the second or constant term be written of the same size with the printed figures; apply this log. co-tang. successively to the log. co-sines of the polar angles: Then the sum of the



**PRACTICE** the two log<sup>s</sup>. being written down each time, will give the log. tangents of the several latitudes arrived at.

By this method, each proportion will be worked by writing down only one line.

Hence it appears, the ship must first sail from the lat. 37° 00' N. to lat. 38° 05' N.; thence to lat. 38° 56' N.; thence to lat. 39° 33'; thence to lat. 39° 57' N.; thence to lat. 40° 09' N., which is the greatest latitude she will go to; and from thence she must proceed through the latitudes 39° 57', 39° 33', 38°

56', 38° 05', and fo to 37° 00', the parallel she fet out from, and in which she is to find the place she is bound to.

Now between these several latitudes, with the respective differences of longitude, find by Mercator's sailing the courses and distances.

If the results of the several operations, in the questions of great circle sailing be entered in such a table as the following, it will be found of some convenience to the operator.

Polar angles.	Succell. longs.	Succell. lats.	Diff. long.	Diff. lat.	Merid. parts.	Merid. diff. lat.	Cour.	Diff.
The angle IPB 26° 43½'	22° 56'	37° 00'			2392.6			
IPa 21 43½'	27 56	38 05	300	65	2474.6	82.0	74.43	246.6
IPb 16 43½'	32 56	38 56	300	51	2539.8	65.2	77.44	240.0
IPc 11 43½'	37 56	39 33	300	37	2587.6	47.8	80.57	235.2
IPd 6 43½'	42 56	39 57	300	24	2618.8	31.2	84.04	232.2
	49 39½'	40 09	403.5	12	2634.5	15.7	87.46	307.9
								1261.9

In the first column are the angles at the pole contained between the perpendicular and the several meridians differing by 5° of longitude.

In the second column, the departed longitude 22° 56' being increased by the differences of longitude, make the successive longitudes come to.

In the third column are the successive latitudes passed thro' in sailing from the place fet out from to the greatest latitude.

In the fourth and fifth columns are the differences between the longitudes and latitudes in the second and third columns.

In the sixth column are the meridional parts to the successive latitudes; and in the seventh column are the meridional diff. of latitudes.

The eight and ninth columns contain the courses and distances between the places answering to the second and third columns.

The numbers in the third, eighth, and ninth columns, are found by working the logarithmic proportions on a waffe paper; but the work is here omitted, as it is so easily supplied.

Now the column of distances being summed up amounts to 1261.9; which being doubled, gives 2523.8 miles for the distance between the two places.

And the courses the ship must steer are, 1st, N. 74° 43' W.; 2d, N. 77° 44' W.; 3d, N. 80° 57' W.; 4th, N. 84° 04' W.; 5th, N. 87° 46' W.; 6th, S. 87° 46' W.; 7th, S. 84° 04' W.; 8th, S. 80° 57' W.; 9th, S. 77° 44' W.; 10th, S. 74° 43' W.; and on these courses she must run the respective distances standing against them.

Having now shewn the method of solving the different cases of navigation mathematically, and supposing the course of the ship and distance run to be always exactly known, we shall now proceed to give an account of those mechanical methods by which the ship's course is observed, and the frequent variations and errors in it corrected at convenient times.

§ 7. Of the Log-line and Compass.

1. THE method commonly made use of for mea-

suring a ship's way at sea, or how far she runs in a given space of time, is by the LOG-LINE, and Half-minute Glafs.

2. The log, fig. 3. is generally about a quarter of Plate an inch thick, and five or six inches from the angular point *a* to the circumference *b*. It is balanced by a thin plate of lead, nailed upon the arch, so as to swim perpendicularly in the water, with about  $\frac{1}{2}$  in pressed under the surface. The line is fastened to the log by means of two legs *a* and *b*, fig. 2. one of which passes thro' a hole *a* at the corner, and is knotted on the opposite side; whilst the other leg is attached to the arch by a pin *b*, fixed in another hole, so as to draw out occasionally. By these legs the log is hung in *equilibrium*, and the line, which is united to it, is divided into certain spaces, which are in proportion to an equal number of geographical miles, as a half minute or quarter minute is to an hour of time.

3. These spaces are called *knots*, because at the end of each of them there is a piece of twine with knots in it, interveed between the strands of the line, which shews how many of these spaces or knots are run out during the half minute. They commonly begin to be counted at the distance of about 10 fathom or 60 feet from the log; that fo the log, when it is hove overboard, may be out of the eddy of the ship's wake before they begin to count; and for the more ready discovery of this point of commencement, there is commonly fastened at it a piece of red rag.

4. The log being thus prepared, and hove overboard from the poop, and the line veered out (by the help of a reel (fig. 4.) that turns easily, and about which it is wound) as fast as the log will carry it away, or rather as the ship sails from it, will shew, according to the time of veering, how far the ship has run in a given time, and consequently her rate of sailing.

5. A degree of a meridian, according to the exactest measures, contains about 69 545 English miles; and each mile by the statute being 5280 feet, therefore a degree of a meridian will be about 367,200 feet; whence the  $\frac{1}{60}$  of that, viz. a minute, or nautical mile, must contain 6120 standard feet; consequently, since  $\frac{1}{2}$  minute

**PRACTICE**  $\frac{1}{2}$  minute is the  $\frac{1}{120}$  part of an hour, and each knot being the same part of a nautical mile, it follows, that each knot will contain the  $\frac{1}{120}$  of 6120 feet, *viz.* 51 feet.

6. Hence it is evident, that whatever number of knots the ship runs in half a minute, the same number of miles she will run in one hour, supposing her to run with the same degree of velocity during that time; and therefore it is the general way to have the log every hour to know her rate of failing: but if the force or direction of the wind vary, and not continue the same during the whole hour; or if there has been more fail set, or any fail handed, that so the ship has run swifter or slower in any part of the hour than she did at the time of leaving the log; then there must be an allowance made accordingly for it, and this must be according to the discretion of the artist.

7. Sometimes, when the ship is before the wind, and there is a great sea setting after her, it will bring home the log, and consequently the ship will fail faster than is given by the log. In this case it is usual, if there be a very great sea, to allow one mile in ten, and less in proportion, if the sea be not so great. But for the generality, the ship's way is really greater than that given by the log; and therefore, in order to have the reckoning rather before than behind the ship, (which is the safest way), it will be proper to make the space on the log-line between knot and knot to consist of 50 feet instead of 51.

8. If the space between knot and knot on the log-line should happen to be too great in proportion to the half-minute glass, *viz.* greater than 50 feet, then the distance given by the log will be too short; and if that space be too small, then the distance run (given by the log) will be too great: therefore, to find the true distance run in either case, having measured the distance between knot and knot, we have the following proportion, *viz.*

As the true distance, 50 feet, is to the measured distance; so are the miles of distance given by the log, to the true distance in miles that the ship has run.

**EXAMPLE I.** Suppose a ship runs at the rate of  $6\frac{1}{2}$  knots in half a minute; but measuring the space between knot and knot, I find it to be 56 feet: Required the true distance in miles.

Making it, As 50 feet is to 56 feet, so is 6.25 knots to 7 knots; I find that the true rate of failing is 7 miles in the hour.

**EXAMPLE II.** Suppose a ship runs at the rate of  $6\frac{1}{2}$  knots in half a minute; but measuring the space between knot and knot, I find it to be only 44 feet: Required the true rate of failing.

Making it, As 50 feet is to 44 feet, so is 6.5 knots to 5.72 knots; I find that the true rate of failing is 5.72 miles in the hour.

9. Again, supposing the distance between knot and knot on the log-line to be exactly 50 feet, but that the glass is not 30 seconds; then, if the glass require longer time to run than 30 seconds, the distance given will be too great, if estimated by allowing one mile for every knot run in the time the glass runs; and, on the contrary, if the glass requires less time to run than 30 seconds, it will give the distance failed too small. Consequently, to find the true distance in either case, we must measure the time the glass requires to run out

(by the method in the following article); then we have **PRACTICE** the following proportion, *viz.*

As the number of seconds the glass runs, is to half a minute, or 30 seconds; so is the distance given by the log, to the true distance.

**EXAMPLE I.** Suppose a ship runs at the rate of  $7\frac{1}{2}$  knots in the time the glass runs; but measuring the glass, I find it runs 34 seconds: Required the true distance failed.

Making it, As 34 seconds is to 30 seconds, so is 7.5 to 6.6; I find that the ship fails at the rate of 6.6 miles an hour.

**EXAMPLE II.** Suppose a ship runs at the rate of  $6\frac{1}{2}$  knots; but measuring the glass, I find it runs only 25 seconds: Required the true rate of failing.

Making it, As 25 seconds is to 30 seconds, so is 6.5 knots to 7.8 knots; I find that the true rate of failing is 7.8 miles an hour.

10. In order to know how many seconds the glass runs, you may try it by a watch or clock that vibrates seconds; but if neither of these be at hand, then take a line, and to the one end fastening a plummet, hang the other upon a nail or peg, so as the distance from the peg to the centre of the plummet be  $39\frac{1}{2}$  inches: then this put into motion will vibrate seconds; *i. e.* every time it passes the perpendicular, you are to count one second; consequently, by observing the number of vibrations that it makes during the time the glass is running, we know how many seconds the glass runs.

11. If there be an error both in the log-line and half-minute glass, *viz.* if the distance between knot and knot and the log-line be either greater or less than 50 feet, and the glass runs either more or less than 30 seconds; then the finding out the ship's true distance will be somewhat more complicated, and admit of three cases, *viz.*

**CASE I.** If the glass runs more than 30 seconds, and the distance between knot and knot be less than 50 feet, then the distance given by the log-line, *viz.* by allowing 1 mile for each knot the ship sails while the glass is running, will always be greater than the true distance, since either of these errors gives the distance too great. Consequently, to find the true rate of failing in this case, we must first find (by Art. 8.) the distance, on the supposition that the log-line is only wrong, and then with this (by Art. 9.) we shall find the true distance.

**EXAMPLE.** Suppose a ship is found to run at the rate of 6 knots; but examining the glass, I find it runs 35 seconds; and measuring the log-line, I find the distance between knot and knot to be but 46 feet: Required the true distance run.

First, (by Art. 8.) We have the following proportion, *viz.* As 50 feet: 46 feet :: 6 knots: 5.52 knots. Then (by Art. 9.) As 35 seconds: 30 seconds :: 5.52 knots: 4.73 knots. Consequently the true rate of failing is 4.73 miles an hour.

**CASE II.** If the glass be less than 30 seconds, and the place between knot and knot be more than 50 feet; then the distance given by the log will always be less than the true distance, since either of these errors lessens the true distance.

**EXAMPLE.** Suppose a ship is found to run at the rate of 7 knots; but examining the glass, I find it runs only 25 seconds; and measuring the space between

tween

**PRACTICE** tween knot and knot on the log-line, I find it is 54 feet : Required the true rate of sailing.

First, (by Art. 9.) As 25 seconds : 30 seconds :: 7 knots : 8.4 knots. Then (by Art. 8.) As 50 feet : 54 feet :: 8.4 knots : 9.072 knots. Consequently the true rate of sailing is 9.072 miles an hour.

**CASE III.** If the glass runs more than 30 seconds, and the space between knot and knot be greater than 50 feet; or if the glass runs less than 30 seconds, and the space between knot and knot be less than 50 feet; then, since in either of these two cases the effects of the errors are contrary, it is plain the distance will sometimes be too great, and sometimes too little, according as the greater quantity of the error lies; as will be evident from the following examples.

**EXAMPLE I.** Suppose a ship is found to run at the rate of 9½ knots per glass; but examining the glass, it is found to run 36 seconds; and by measuring the space between knot and knot, it is found to be 58 feet : Required the true rate of sailing.

First, (by Art. 8.) As 50 feet : 58 feet :: 9.5 knots : 11.02 knots. Then (by Art. 9.) As 38 seconds : 30 seconds :: 11.02 knots : 8.7 knots. Consequently the ship's true rate of sailing is 8.7 miles an hour.

**EXAMPLE II.** Suppose a ship runs at the rate of 6 knots per glass; but examining the glass, it is found to run only 20 seconds; and by measuring the log-line, the distance between knot and knot is found to be but 38 feet : Required the true rate of sailing.

First, (by Art. 8.) As 50 feet : 38 feet :: 6 knots : 4.56 knots. Then (by Art. 9.) As 20 seconds : 30 seconds :: 4.56 knots : 6.84 knots. Consequently the true rate of sailing is 6.83 miles an hour.

But if in this case it happen, that the time the glass takes to run be to the distance between knot and knot, as 30, the seconds in half a minute, is to 50, the true distance between knot and knot; then it is plain, that whatever number of seconds the glass consists of, and whatever number of feet is contained between knot and knot, yet the distance given by the log-line will be the true distance in miles.

12. Though the method of measuring the ship's way by the log-line, described in the foregoing articles, be that which is now commonly made use of; yet it is subject to several errors, and these very considerable. For, first, the half-minute or quarter-minute glasses (by which and the log the ship's way is determined) are seldom or never true, because dry and wet weather have a great influence on them; so that at one time they may run more, and at another time fewer, than 30 seconds; and it is evident that a small error in the glass will cause a sensible one in the ship's way. Again, the chief property of the log is to have it swim upright, or perpendicular to the horizon: but this is too often wanting in logs, because few seamen examine whether it is so or not, and generally take it upon trust, being satisfied if it weigh a little more than the stern than the head. And from this there flows an error in the reckoning; for if the log does not swim upright, it will not hold water, nor remain steady in the place where it is heaved, since the least check in the hand in veering the line will make it come up several feet: this repeated will make the errors become fathoms, and perhaps knots, which, how insignificant sooner they appear, are miles and parts of miles, and amount to a good deal in a long voyage. Another

**PRACTICE** inconvenience attending the log-line is its stretching and shrinking; for when a new line is first used, let it be ever so well stretched upon the deck, and measured as true as possible, yet after wetting it shrinks considerably; and consequently to be the better assured of the ship's way by the log-line, we ought to measure and alter the knots on it every time before we use it; but this is seldom done oftener than once a week, and sometimes not above once or twice in a whole voyage: also when the line is measured to its greatest degree of shrinking, it is generally left there; and when, by much use, it comes to stretch again, it is seldom or never mended, though it will stretch beyond what it first shrank. These and many other errors, too well known, attending that method of measuring the ship's way by the log-line, plainly accounts for a great many errors committed in reckonings. So it is to be wished, that either this method were improved or amended, or that some other method less subject to error were found out.

13. The meridian and prime vertical of any place cuts the horizon in 4 points, at 90 degrees distance from one another, viz. *North, South, East and West*; that part of the meridian which extends itself from the place to the north point of the horizon is called the *north line*; that which tends to the south point of the horizon is called the *south line*; and that part of the prime vertical which extends towards the right hand of the observer, when his face is turned to the north, is called the *east line*; and lastly, that part of the prime vertical which tends towards the left hand is called the *west line*; the four points in which these lines meet the horizon are called the *cardinal points*.

14. In order to determine the course of the winds, and to discover their various alterations or shiftings, each quadrant of the horizon, intercepted between the meridian and prime vertical, is usually divided into eight equal parts, and consequently the whole horizon into thirty-two; and the lines drawn from the place on which the observer standeth, to the points of division in his horizon, are called *rhumb-lines*; the four principal of which are those described in the preceding article, each of them having its name from the cardinal point in the horizon towards which it tends: the rest of the rhumb-lines have their names compounded of the principal lines on each side of them, as in the figure (Plate CII. N° 1.); and over whichever of these lines the course of the wind is directed, that wind takes its name accordingly.

15. The instrument commonly used at sea for directing the ship's way is called the *MARINER'S COMPASS*; which consists of a card and two boxes. The card is a circle made to represent the horizon, whose circumference is quartered and divided into degrees, and also into thirty-two equal parts, by lines drawn from the centre to the several points of division, called *points of the compass*. On the back-side of the card, and just below the south and north line, is fixed a steel needle with a brass cupola, or hollow centre in the middle, which is placed upon the end of a fine pin, upon which the card may easily turn about: the needle is touched with a loadstone, by which a certain virtue is infused into it, that makes it (and consequently the south and north line on the card above it) hang nearly in the plane of the meridian; by which means the south and north

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north lines on the card produced would meet the horizon in the fourth and north points; and consequently all the other lines on the card produced would meet the horizon in the respective points.

Elate CCH.

16. The card is represented in N<sup>o</sup> 1. in which you may observe, that the capital letters N, S, E, W, denote the four cardinal points, viz. N the North, S the South, &c. and the small letter *b* signifies the word *by*. The *rhumbs* in the middle between any two of the cardinals are expressed by the letters denoting these cardinals, that which denotes the point lying in the middle between the north and east is expressed N. E. which is to be read *North-east*; also S. W. denotes the *South-west* rhumb, &c.; the other rhumbs are expressed according to their situation with respect to these middle rhumbs and the nearest cardinals, as is plain from the foregoing figure.

17. The card is put into a round box, made for it, having a pin erected in the middle, upon which the hollow centre of the needle is fixed, so as the card may lie horizontal, and easily vibrate according to the motion of the needle: the box is covered over with a smooth glass, and is hung in a brass hoop upon two cylindrical pins, diametrically opposite to one another; and this hoop is hung within another brass circle, upon two pins at right angles with the former. These two circles, and the box, are placed in another square wooden box, so that the innermost box, and consequently the card, may keep horizontal which way soever the ship heels.

18. Since the meridians do all meet at the poles, and there form certain angles with one another; and since, if we move ever so little towards the east or west, from one place to another, we thereby change our meridian, and in every place the east and west line being perpendicular to the meridian; it follows, that the east and west line in the first place will not coincide with the east and west line in the second, but be inclined to it at a certain angle: and consequently all the other rhumb-lines at each place will be inclined to each other, they always forming the same angles with the meridian. Hence it follows, that all rhumbs, except the four cardinals, must be curves or helispherical lines, always tending towards the pole, and approaching it by infinite gyrations or turnings, but never falling into it. Thus let P (N<sup>o</sup> 2.) be the pole, EQ an arch of the equator, PE, PA, &c. meridians, and EFGHL any rhumb: then because the angles PEF, PFG, &c. are by the nature of the rhumb-line equal, it is evident that it will form a curve-line on the surface of the globe, always approaching the pole P, but never falling into it; for if it were possible for it to fall into the pole, then it would follow, that the same line could cut an infinite number of other lines at equal angles, in the same point; which is absurd.

19. Because there are 32 rhumbs (or points in the compass) equally distant from one another, therefore the angle contained between any two of them adjacent will be  $11^{\circ} 15'$ , viz.  $\frac{1}{8}$  part of  $360^{\circ}$ ; and so the angle contained between the meridian and the N.E. will be  $11^{\circ} 15'$ , and between the meridian and the N.N.E. will be  $22^{\circ} 30'$ ; and so of the rest, as in the following table.

A TABLE of the Angles which every  $\frac{1}{8}$  Point of the Compass makes with the Meridian.

North	South	Points	D.	M.	North	South
		$\frac{1}{8}$	02	49		
		$\frac{2}{8}$	05	37		
		$\frac{3}{8}$	08	26		
N & E	S & E	1	11	15	N & W	S & W
		$\frac{1}{8}$	14	04		
		$\frac{2}{8}$	16	52		
		$\frac{3}{8}$	19	41		
NNE	SSE	2	22	30	NNW	SSW
		$\frac{2}{8}$	25	19		
		$\frac{3}{8}$	28	07		
		$\frac{4}{8}$	30	56		
NE & N	SE & S	3	33	45	NW & N	SW & W
		$\frac{3}{8}$	36	34		
		$\frac{4}{8}$	39	22		
		$\frac{5}{8}$	42	11		
NE	SE	4	45	00	NW	SW
		$\frac{4}{8}$	47	49		
		$\frac{5}{8}$	50	37		
		$\frac{6}{8}$	53	26		
NE & E	SE & E	5	56	15	NW & W	SW & W
		$\frac{5}{8}$	59	04		
		$\frac{6}{8}$	61	52		
		$\frac{7}{8}$	64	42		
ENE	ESE	6	67	30	WNW	WSW
		$\frac{6}{8}$	70	19		
		$\frac{7}{8}$	73	07		
		$\frac{7}{8}$	75	56		
E & N	E & S	7	78	45	W & N	W & S
		$\frac{7}{8}$	81	34		
		$\frac{8}{8}$	84	22		
		$\frac{8}{8}$	87	11		
East		8	90	00		West

§ 8. Concerning Currents, and how to make proper allowances.

1. CURRENTS are certain settings of the stream, by which all bodies (as ships, &c.) moving therein, are compelled to alter their course or velocity, or both; and submit to the motion impressed upon them by the current.

CASE I. If the current sets just with the course of the ship, *i. e.* moves on the same rhumb with it; then the motion of the ship is increased, by as much as is the drift or velocity of the current.

EXAMPLE. Suppose a ship sails SE & S at the rate of 6 miles an hour, in a current that sets SE & S 2 miles an hour: Required her true rate of sailing.

Here it is evident that the ship's true rate of sailing will be 8 miles an hour.

CASE II. If the current sets directly against the ship's course, then the motion of the ship is lessened

by

**PRACTICE** by as much as is the velocity of the current.

**EXAMPLE.** Suppose a ships fails SSW at the rate of 10 miles an hour, in a current that sets NNE 6 miles an hour: Required the ship's true rate of failing.

Here it is evident that the ship's true rate of failing will be 4 miles an hour. Hence it is plain,

**COR. I.** If the velocity of the current be less than the velocity of the ship, then the ship will get so much a-head as is the difference of these velocities.

**COR. II.** If the velocity of the current be greater than that of the ship, then the ship will fall so much a-head as is the difference of these velocities.

**COR. III.** Lastly, If the velocity of the current be equal to that of the ship, then the ship will stand still; the one velocity destroying the other.

**CASE III.** If the current thwarts the course of the ship, then it not only lessens or augments her velocity, but gives her a new direction compounded of the course she steers, and the setting of the current, as is manifest from the following

**LEMMA.** If a body at A ( $N^{\circ} 26.$ ) be impelled by two forces at the same time, the one in the direction AB capable to carry that body from A to B in a certain space of time, and the other in the direction AD capable to carry it from A to D in the same time; complete the parallelogram ABCD, and draw the diagonal AC; then the body at A, agitated by these two forces together, will move along the line BC, and will be in the point C at the end of the time in which it would have moved along AD or AB with the forces separately applied.

Hence the solution of the following examples will be evident.

**EXAMPLE I.** Suppose a ship fails (by the compass) directly south 96 miles in 24 hours, in a current that sets east 45 miles in the same time: Required the ship's true course and distance.

**GEOMETRICALLY.** Draw AD (see  $N^{\circ} 26.$ ) to represent the south and north line of the ship at A, which make equal to 96; from D draw DC perpendicular to AD, equal to 45; and join AC. Then C will be the ship's true place, AC her true distance, and the angle CAD the true course. To find which,

**By CALCULATION;**

First, For the true course DAC, it will be, (by rectangular trigonometry),

As the apparent distance AD - 96 - 1.98227  
is to the current's motion DC - 45 - 1.65321  
so is radius - - - - - 10.00000

to the tangent of the true }  
course DAC } -  $25^{\circ}, 07'$  9.67094  
consequently the ship's true course is S  $25^{\circ} 07'$  E, or SSE  $2^{\circ} 37'$  easterly.

Then for the true distance AC, it will be, (by rectangular trigonometry),

As the sine of the course A -  $25^{\circ}, 07'$  - 9.62784  
is to the departure DC - 45 - 1.65321  
so is radius - - - - - 10.00000  
to the true distance AC - 106 - 2.02537

**EXAMPLE.** Suppose a ship fails SE 120 miles in 20 hours, in a current that sets W $\frac{1}{2}$ N at the rate of 2 miles an hour: Required the ship's true course and distance failed in that time.

**GEOMETRICALLY.** Having drawn the compass

NESW ( $N^{\circ} 27.$ ) let C represent the place the ship failed from; draw the SE line CA, which make equal to 120; then will A be the place the ship caped at.

From A draw AB parallel to the W $\frac{1}{2}$ N line CD, equal to 40, the motion of the current in 20 hours, and join CB; then B will be the ship's true place at the end of 20 hours, CB her true distance, and the angle SCB her true course. To find which,

**By CALCULATION;**

In the triangle ABC, are given CA 120, AB 40, and the angle CAB equal to  $34^{\circ} 45'$ , the distance between the ES and SE lines, to find the angles B and C, and the side CB.

First, For the angles C and B, it will be, (by oblique trigonometry),

As the sum of the sides CA and AB 160 - 2.20412  
is to their difference - - - - - 80 - 1.90309  
so is the tang. of half the sum }  
of the angles B and C } -  $73^{\circ}, 07'$  10.51783  
to the tang. of half their diff. - 59, 45 10.21680  
consequently the angle B will be  $131^{\circ}, 52'$ , and the angle ACB  $14^{\circ} 23'$ . Hence the true course is S  $30^{\circ} 37'$  E, or SSE  $2^{\circ} 07'$  easterly.

Then for the true distance CB, it will be, (by oblique trigonometry),

As the sine of B -  $131^{\circ}, 52'$  - 9.87198  
is to AC - 120 - 2.07918  
so is the sine of A -  $33^{\circ}, 45'$  - 9.74474  
to the true distance CB 89.53 - 1.95194

**EXAMPLE III.** Suppose a ship coming out from sea in the night, has sight of Scilly light, bearing NE $\frac{1}{2}$ N distance 4 leagues, it being then flood tide setting ENE 2 miles an hour, and the ship running after the rate of 5 miles an hour: Required upon what course and how far she must fail to hit the Lizard, which bears from Scilly E $\frac{1}{2}$ S distance 17 leagues.

**GEOMETRICALLY.** Having drawn the compass NESW ( $N^{\circ} 28.$ ) let A represent the ship's place at sea, and draw the NE $\frac{1}{2}$ N line AS, which make equal to 12 miles; so S will represent Scilly.

From S draw SL equal to 51 miles, and parallel to the E $\frac{1}{2}$ S line; then L will represent the Lizard.

From L draw LC parallel to the ENE line, equal to 2 miles, and from C draw CD equal to 5 miles meeting AL in D; then from A draw AB parallel to CD meeting LC produced in B; and AB will be the required distance, and SAB the true course. To find which,

**By CALCULATION;**

In the triangle ASL are given the side AS equal to 12 miles, the side SL equal to 51, and the angle ASL equal to  $118^{\circ} 07'$ , the distance between the NE $\frac{1}{2}$ N and W $\frac{1}{2}$ N lines; to find the angles SAL and SLA. Consequently, (by oblique trigonometry), it will be,

As the sum of the sides AS and SL - 63 - 1.79934  
is to their difference - - - - - 39 - 1.59106  
so is the tang of half the sum }  
of the angles SAL and SLA }  $30^{\circ}, 56'$  9.77763  
to the tang. of half their diff. -  $20^{\circ}, 21'$  9.56935

consequently the angle SAL, will be  $51^{\circ} 17'$ ; and so the direct bearing of the Lizard from the ship will be N  $85^{\circ} 02'$  E, or E $\frac{1}{2}$ N  $6^{\circ} 17'$  E; and for the distance AL, it will be, (by oblique trigonometry),

<b>PRACTICE</b> As the sine of SAL	51°, 17'	9.89223
is to SL	51'	1.70757
so is the sine of ASL	118°, 07'	9.94546
to AL	57.65	1.76080

the distance between the ship and the Lizard.

Again, in the triangle DLC, are given the angle L equal to  $17^{\circ} 32'$ , the distance between the ENE and N  $85^{\circ} 02' E$  lines; the side LC, equal to 2 miles, the current's drift in an hour; and the side CD, equal to 5 miles, the ship's run in the same time. Hence for the angle D, it will be, (by oblique trigonometry),

As the ship's run in 1 hour DC	5	0.69897
is to the sine of L	$17^{\circ}, 32'$	9.47894
so is the current's drift LC	2	0.30103
to the sine of D	$6^{\circ}, 55'$	9.08100

consequently, since by construction the angle LAB is equal to the angle LDC, the course the ship must steer is S  $88^{\circ}, 03' E$ .

Then for the distance AB, it will be, (by oblique trigonometry),

As the sine of B	$155^{\circ}, 33'$	9.61689
is to AL	57.65	1.76080
so is the sine of L	17.32	9.47894
to AB	41.96	1.62285

consequently, since the ship is sailing at the rate of 5 miles an hour, it follows, that in sailing  $8^h 24^m S 88^{\circ} 03' E$ , she will arrive at the Lizard.

**EXAMPLE IV.** A ship from a certain headland in the latitude of  $34^{\circ} 00'$  north, sails SE/S 12 miles in 3 hours, in a current that sets between north and east; and then the same headland is found to bear WNW, and the ship to be in the latitude of  $33^{\circ} 52'$  north: Required the setting and drift of the current.

**GEOMETRICALLY.** Having drawn the compass NESW ( $N^{\circ} 20'$ ) let A represent the place of the ship, and draw the SE/S line AB, equal to 12 miles, also the ESE line AC.

Set off from A upon the meridian AD, equal to 8 miles, the difference of latitude, and through D draw DC parallel to the east and west line WE, meeting AC in C. Join C and B with the right line BC; then C will be the ship's place, the angle ABC the setting of the current from the SE/S line, and the line BC will be the drift of the current in 3 hours. To find which,

**By CALCULATION;**

In the triangle ABC, right-angled at D, are given the difference of latitude AD equal to 8 miles, the angle DAC equal to  $67^{\circ} 30'$ . Whence for AC, the distance the ship has sailed, it will be

As radius		10.00000
is to the diff. of latitude AD	8	0.90309
so is the secant of the course	$67^{\circ}, 30'$	10.41716
DAC		
to the distance run AC	20.9	1.32025

Again, in the triangle ABC, are given AB equal to 12 miles, AC equal to 20.9, and the angle BAC equal to  $30^{\circ} 45'$ , the distance between the SE/S and ESE lines. Whence, for the angle at B, it will be,

As the sum of the sides AC and AB	32.9	1.51720
is to their difference	8.9	0.94930
so is the tang. of half the		
sum of the angles B and C	$73^{\circ}, 07'$	10.51806

to tang. of  $\frac{1}{2}$  their diff.  $41^{\circ}, 43^{\frac{1}{2}}'$   $9.95025$  consequently the angle B is  $114^{\circ} 51'$ ; and for the set-

ting of the current will be N  $81^{\circ} 06' E$ , or  $E 2^{\circ} 06' E$ . Then for BC, the current's drift in 3 hours, it will be,

As the sine of B	$114^{\circ}, 51'$	9.92700
is to the distance run AC	20.9	1.32025
so is the sine of A	$33^{\circ}, 45'$	9.74474
to BC	12.8	1.10719

the current's drift in 3 hours; and consequently the current sets E/N  $2^{\circ} 21' E$  4.266 miles an hour.

*§. 9. Concerning the VARIATION of the COMPASS, and how to find it from the true and observed AMPLITUDES or AZIMUTHS of the sun.*

1. THE variation of the compass is how far the north or south point of the needle stands from the true north or north point of the horizon towards the east or west; or it is an arch of the horizon intercepted between the meridian of the place of observation and the magnetic meridian.

2. It is absolutely necessary to know the variation of the compass at sea, in order to correct the ship's course; for since the ship's course is directed by the compass, it is evident that if the compass be wrong, the true course will differ from the observed, and consequently the whole reckoning differ from the truth.

3. The sun's true amplitude is an arch of the horizon comprehended between the true east or west point thereof, and the centre of the sun at rising or setting; or it is the number of degrees, &c. that the centre of the sun is distant from the true east or west point of the horizon, towards the south or north.

4. The sun's magnetic amplitude is the number of degrees that the centre of the sun is from the east or west point of the compass, towards the south or north point of the same at rising or setting.

5. Having the declination of the sun, together with the latitude of the place of observation, we may from thence find the sun's true amplitude, by the following astronomical proposition, viz.

As the co-sine of the latitude

is to the radius

So is the sine of the sun's declination

to the sine of the sun's true amplitude

which will be north or south according as the sun's declination is north or south.

**EXAMPLE.** Required the sun's true amplitude in the latitude of  $41^{\circ} 50'$  north, on the 23d day of April 1731.

First, I find (from the tables of the sun's declination) that the sun's declination the 23d of April is  $15^{\circ} 54'$  north; then for the true amplitude, it will be, by the former analogy,

As the co-sine of the lat.	$41^{\circ} 50'$	9.87221
is to radius		10.00000
so is the sine of the decl.	$15^{\circ}, 54'$ ,	9.43769
to the sine of the amplit.	$21, 35,$	9.56548

which is north, because the declination is north at that time; and consequently, in the latitude of  $40^{\circ} 50'$  north, the sun rises on the 23d of April  $21^{\circ} 35'$  from the east part of the horizon towards the north, and sets so much from the west the same way.

6. The sun's true azimuth is the arch of the horizon intercepted between the meridian and the vertical circle passing through the centre of the sun at the time of observation.

7. The sun's magnetic azimuth is the arch of the horizon, intercepted between the magnetic meridian and the vertical, passing through the sun.

8. Having the latitude of the place of observation, together with the sun's declination and altitude at the time of observation, we may find his true azimuth after the following method, viz.

Make it,

As the tangent of half the complement of the latitude is to the tangent of half the sum of the distance of the sun from the pole and complement of the altitude

So is the tangent of half the difference between the distance of the sun from the pole and complement of the altitude

To the tangent of a fourth arch which fourth arch added to half the complement of the latitude will give a fifth arch, and this fifth arch lessened by the complement of the latitude will give a sixth arch.

Then make it,

As the radius

is to the tangent of the altitude

So is the tangent of the sixth arch

to the co-sine of the sun's azimuth

which is to be counted from the south or north, to the east or west, according as the sun is situated with respect to the place of observation.

If the latitude of the place and declination of the sun be both north or both south, then the declination taken from  $90^\circ$  will give the sun's distance from the pole; but if the latitude and declination be on contrary sides of the equator, then the declination added to  $90^\circ$  will give the sun's distance from the nearest pole to the place of observation.

EXAMPLE. In the latitude of  $51^\circ 32'$  north, the sun having  $19^\circ 34'$  north declination, his altitude was found by observation to be  $38^\circ 18'$ : Required the azimuth.

By the first of the foregoing analogies, it will be

As the tangent of  $\frac{1}{2}$  the complement of the latitude }  $19^\circ, 14'$  9.54269

is to the tangent of  $\frac{1}{2}$  the sum of the distance of the sun from the pole and complement of the altitude }  $61, 01$  10.25655

So is the tangent of half their difference }  $9, 19$  7.21499

to the tang. of a 4th arch  $40, 20$  9.92885

which fourth arch  $40^\circ 20'$ , added to  $19^\circ 14'$ , half the

complement of the latitude, gives a fifth arch  $59^\circ 34'$ ;

and this fifth arch lessened by  $38^\circ 18'$ , the complement

of the latitude, gives the sixth arch  $21^\circ 06'$ ; then

for the azimuth, it will be, by the second of the preceding analogies,

As radius -  $10.00000$

is to the tang. of the altitude  $38^\circ, 18'$  9.89749

So is the tang. of the sixth arch  $21, 06$  - 9.58644

to the co-sine of the azimuth  $72, 15$  - 9.48393

which, because the latitude is north and the sun south

of the place of observation, must be counted from the

south towards the east or west; and consequently, if

the altitude of the sun was taken in the morning, the

azimuth will be  $S 72^\circ 15' E$ , or  $ESE 4^\circ 45' E$ ;

but if the altitude was taken in the afternoon, the

azimuth will be  $S 72^\circ 15' W$ , or  $WSW 4^\circ 45'$  westerly.

9. Having found the sun's true amplitude or azimuth by the preceding analogies, and his magnetic amplitude or azimuth by observation, it is evident, if they agree, there is no variation; but if they disagree, then if the true and observed amplitudes at the rising or setting of the sun be both of the same name, *i. e.* either both north, or both south, their difference is the variation; but if they be of different names, *i. e.* one north and the other south, their sum is the variation. Again, if the true and observed azimuth be both of the same name, *i. e.* either both east or both west, their difference is the variation: but if they be of different names, their sum is the variation: And to know whether the variation is easterly, observe this general rule, viz.

Let the observer's face be turned to the sun: then if the true amplitude or azimuth be to the right-hand of the observed, the variation is easterly; but if be to the left, westerly.

To explain which, Let NESW ( $N^\circ 30'$ ) represent Plate CCHH

a compass, and suppose the sun is really  $E8S$  at the time of observation, but the observer sees him off the east point of the compass, and so the true amplitude or azimuth of the sun is to the right of the magnetic or observed; here it is evident that the  $E8S$  point of the compass ought to lie where the east point is, and so the north where the  $N8W$  is; consequently the north point of the compass is a point too far east, *i. e.* the variation in this case is easterly. The same will hold when the amplitude or azimuth is taken on the west side of the meridian.

Again, let the true amplitude or azimuth be to the left-hand of the observed. Thus, suppose the sun is really  $E4N$  at the time of observation, but the observer sees him off the east point of the compass, and so the true amplitude or azimuth to the left of the observed: Here it is evident that the  $E4N$  point of the compass ought to stand where the east point is, and so the north where the  $N8E$  point is; consequently the north point of the compass lies a point too far westerly; so in this case the variation is west. The same will hold when the sun is observed on the west side of the meridian.

EXAMPLE I. Suppose the sun's true amplitude at rising is found to be  $E 14^\circ 20' N$ , but by the compass it is found to be  $E 26^\circ 12'$ : Required the variation, and which way it is.

Since they are both the same way, therefore  
From the magnetic amplitude -  $E 26^\circ, 12' N$ .  
take the true amplitude -  $E 14, 20 N$ .

and there remains the variation -  $11, 52 E$ .  
which is easterly, because in this case the true amplitude is the right of the observed.

EXAMPLE II. Suppose the sun's true amplitude at setting is  $W 34^\circ 26' S$ , and his magnetic amplitude  $W 23^\circ 13' S$ : Required the variation, and which way it is.

Since they lie both the same way, therefore  
From the sun's true amplitude -  $W 43^\circ, 26' S$ .  
take his magnetic amplitude -  $W 23, 13 S$ .

there remains the variation -  $11, 13 W$ .  
which

**PRACTICE** which is westerly, because the true amplitude, in this case, is to the left-hand of the observed.

**EXAMPLE III.** Suppose the sun's true altitude at rising is found to be  $13^{\circ} 24' N$ , and his magnetic  $E 12^{\circ} 32' S$ : Required the variation, and which way it lies.

Since the true and observed amplitudes lie different ways, therefore

To the true amplitude	-	$E 13^{\circ}, 24' N.$
add the magnetic amplitude	-	$E 12, 32 S.$

the sum is the variation -  $25, 56 W.$   
which is westerly, because the true amplitude is, in this case, to the left of the observed.

**EXAMPLE IV.** Suppose the sun's true altitude at setting is found to be  $W 8^{\circ} 24' N$ , but his magnetic amplitude is  $W 10^{\circ} 13' S$ : Required the variation.

To the true amplitude	-	$W 8^{\circ}, 24' N.$
add the magnetic	-	$W 10, 13 S.$

the sum is the variation -  $18, 37 E.$   
which is easterly, because the true amplitude is to the right of the observed.

**EXAMPLE V.** Suppose the sun's true azimuth at the time of observation is found to be  $N 86^{\circ} 40' E$ , but by the compass it is  $N 73^{\circ} 24' E$ : Required the variation, and which way it lies.

From the sun's true azimuth	-	$N 86^{\circ}, 40' E.$
take the magnetical	-	$N 73, 24 E.$

there remains the variation -  $13, 16 E.$   
which is easterly, because the true azimuth is to the right of the observed.

**EXAMPLE VI.** Suppose the sun's true azimuth is  $S 3^{\circ} 24' E$ , and the magnetical  $S 4^{\circ} 36' W$ : Required the variation, and which way it lies.

To the true azimuth	-	$S 3^{\circ}, 24' E.$
add the magnetical azimuth	-	$S 4, 36 W.$

the sum is the variation -  $8, 00 W.$   
which is westerly, because the true azimuth is, in this case, to the left of the observed.

10. The variation of the compass was first observed at London, in the year 1580, to be  $11^{\circ} 15'$  easterly, and in the year 1622 it was  $6^{\circ} 0' E.$ ; also in the year 1634, it was  $4^{\circ} 05' E.$  still decreasing, and the needle approaching the true meridian, till it coincided with it, and then there was no variation; after which, the variation began to be westerly; and in the year 1672, it was observed to be  $2^{\circ} 30' W.$ ; also in the year 1683, it was  $4^{\circ} 30' W.$ ; and since that time the variation still continues at London to increase westerly; but how far it will go that way, time and observations will probably be the only means to discover.

Again, at Paris, in the year 1640, the variation was  $3^{\circ} 00' E.$ ; and in the year 1666, there was no variation; but in the year 1681, it was  $2^{\circ} 30' W.$  and still continues to go westerly.

In short, from observations made in different parts of the world, it appears, that in different places the variation differs both as to its quantity and denomination, it being east in one place, and west in another; the true cause and theory of which, for want of a suf-

ficient number of observations, has not as yet been **PRACTICE** fully explained.

§ 10. *The Method of keeping a Journal at sea; and how to correct it, by making proper allowance for the Leeway, Variation, &c.*

1. **LEEWAY** is the angle that the rumb-line, upon which the ship endeavours to sail, makes with the rumb she really sails upon. This is occasioned by the force of the wind or surge of the sea, when she lies to the windward, or is clove-hauled, which causes her to fall off and glide sideways from the point of the compass the capes at. Thus let  $NESW$  ( $N^{\circ} 31.$ ) represent the compass; and suppose a ship at  $C$  capes at, or endeavours to sail upon, the rumb  $Ca$ ; but by the force of the wind, and surge of the sea, she is obliged to fall off, and make her way good upon the rumb  $Cb$ : then the angle  $aCb$  is the leeway; and if that angle be equal to one point, the ship is said to make one point leeway; and if equal to two points, the ship is said to make two points leeway, &c.

The quantity of this angle is very uncertain, because some ships, with the same quantity of sail, and with the same gale, will make more leeway than others; it depending much upon the mould and trim of the ship, and the quantity of water that the draws. The common allowances that are generally made for the leeway, are as follow.

1. If a ship be clove hauled, has all her sails set, the water smooth, and a moderate gale of wind, she is then supposed to make little or no leeway.

2. If it blow so fresh as to cause the small sails be handed, it is usual to allow one point.

3. If it blow so hard that the top-sails must be clove reef, then the common allowance is two points for leeway.

4. If one top-sail must be handed, then the ship is supposed to make between two and three points leeway.

5. When both top-sails must be handed, then the allowance is about four points for leeway.

6. If it blows so hard as to occasion the fore-course to be handed, the allowance is between  $5\frac{1}{2}$  and 6 points.

7. When both main and fore-courses must be handed, then 6 or  $6\frac{1}{2}$  points are commonly allowed for leeway.

8. When the mizen is handed, and the ship is trying a-hull, she is then commonly allowed about 7 points for leeway.

3. Though these rules are such as are generally made use of, yet since the leeway depends much upon the mould and trim of the ship, it is evident that they cannot exactly serve to every ship; and therefore the best way is to find it by observation. Thus, let the ship's wake be set by a compass in the poop, and the opposite rumb is the true course made good by the ship; then the difference between this and the course given by the compass in the binnacle, is the leeway required. If the ship be within sight of land; then the leeway may be exactly found by observing a point on the land which continues to bear the same way, and the distance between the point of the compass



**PRACTICE** pafs it lies upon, and the point the fhip capes at, will be the lee-way. Thus, fuppofe a fhip at C, is lying up Nw<sup>h</sup>, towards A; but inftead of keeping that courfe, fhe is carried on the NNE line CB, and confequently the point B continues to bear the fame way from the fhip: Here it is evident, that the angle ACB, or the diftance between the Nw<sup>h</sup> line that the fhip capes at, and the NNE line that the fhip really fails upon, will be the lee-way.

4. Having the courfe fteered, and the lee-way, given; we may from thence find the true courfe by the following method, viz. Let your face be turned direcdly to the windward; and if the fhip have her larboard tacks on board, count the lee-way from the courfe fteered towards the right hand; but if the ftarboard tacks be on board, then count it from the courfe fteered towards the left hand. Thus, fuppofe the wind at north, and the fhip lies up within 6 points of the wind, with her larboard tacks on board, making one point lee-way; here it is plain, that the courfe fteered is ENE, and the true courfe E<sup>n</sup>N: alfo fuppofe the wind is at NNW, and the fhip lies up within 6½ points of the wind, with her ftarboard tack on board, making 1½ point lee-way; it is evident that the true courfe, in this cafe, is WSW.

5. We have fhewed, in the laft fection, how to find the variation of the compafs; and from what has been faid there, we have this general rule for finding the fhip's true courfe, having the courfe fteered and the variation given, viz. Let your face be turned towards the point of the compafs upon which the fhip is fteered; and if the variation be eafterly, count the quantity of it from the courfe fteered towards the right hand; but if westerly, towards the left hand; and the courfe thus found is the true courfe fteered. Thus, fuppofe the courfe fteered is N<sup>n</sup>E, and the variation one point eafterly; then the true courfe fteered will be NNE: Alfo fuppofe, the courfe fteered is NE<sup>n</sup>E, and the variation one point westerly; then, in this cafe, the true courfe will be NE; and fo of others.

Hence, by knowing the lee-way variation, and courfe fteered, we may from thence find the fhip's true courfe; but if there be a current under foot, then that muft be tried, and proper allowances made for it, as has been fhown in the fection concerning *Currents*, from thence to find the true courfe.

6. After making all the proper allowances for finding the fhip's true courfe, and making as juft an estimate of the diftance as we can; yet by reafon of the many accidents that attend a fhip in a day's running, fuch as different rates of failing between the times of heaving the log; the want of due care at the helm by not keeping her fteady, but fuffering her to yaw and fall off; fudden ftorms, when no account can be kept, &c.; the latitude by account frequently differs from the latitude by obfervation: and when that happens, it is evident there muft be fome error in the reckoning; to difcover which, and where it lies, and alfo how to correct the reckoning, you may obferve the following rules.

1<sup>ft</sup>. If the fhip fail near the meridian, or within 2 or 2½ points thereof; then if the latitude by account difagrees with the latitude by obfervation, it is moft likely that the error lies in the diftance run; for it is plain, that in this cafe it will require a very fenfible

error in the courfe to make any confiderable error in the difference of latitude, which cannot well happen if due care be taken at the helm, and proper allowances be made for the lee-way, variation, and currents. Confequently, if the courfe be pretty near the truth, and the error in the diftance run regularly through the whole, we may, from the latitude obtained by obfervation, correct the diftance and departure by account, by the following analogies, viz.

As the difference of latitude by account  
is to the true difference of latitude,  
So is the departure by account  
to the true departure,  
And fo is the direct diftance by account  
to the true direct diftance.

The reafon of this is plain: for let AB (N<sup>o</sup> 33) denote the meridian of the fhip at A, and fuppofe the fhip fails upon the rhumb AE near the meridian, till by account fhe is found in C, and confequently her difference of latitude by account is AB; but by obfervation fhe is found in the parallel ED, and fo her true difference of latitude is AD, her true diftance AE, and her true departure DE; then, fince the triangles ABC ADE are fimilar, it will be AB: AD :: BC: DE, and AB: AD :: AC: AE.

**EXAMPLE.** Suppofe a fhip from the latitude of 45<sup>o</sup> 20' north, after having failed upon feveral courfes near the meridian for 24 hours, her difference of latitude is computed to be upon the whole 95 miles fotherly, and her departure 34 miles eafterly; but by obfervation fhe is found to be in the latitude of 43<sup>o</sup> 10' north, and confequently her true difference of latitude is 130 miles fotherly: then for the true departure, it will be, As the difference of latitude by account 95 is to the true difference of latitude 130; fo is the departure by account 34 to the true departure 46.52, and fo is the diftance by account 100.9 to the true diftance 138.

2<sup>dly</sup>. If the courfes are for the moft part near the parallel of eaft and weft, and the direct courfe be within 5½ or 6 points of the meridian; then if the latitude by account differs from the obferved latitude, it is moft probable that the error lies in the courfe or diftance, or perhaps both; for in this cafe it is evident, the departure by account will be very nearly true; and thence by the help of this, and the true difference of latitude, may the true courfe and direct diftance be readily found by *Cafe 4. of Plane Sailing*.

**EXAMPLE.** Suppofe a fhip from the latitude of 43<sup>o</sup> 50' north, after having failed upon feveral courfes near the parallel of eaft and weft for the fpace of 24 hours, is found by dead reckoning to be in the latitude of 42<sup>o</sup> 45' north, and to have made 160 miles of wefting; but by a good obfervation the fhip is found to be in the latitude of 42<sup>o</sup> 35' north: Required the true courfe, and direct diftance failed.

With the true difference of latitude 75 miles, and departure 160 miles, we fhall find (by *Cafe 4. of Plane Sailing*) the true courfe to be S. 64<sup>o</sup> 53' W. and the direct diftance 176.7 miles.

3<sup>dly</sup>. If the courfes are for the moft part near the middle of the quadrant, and the direct courfe within 2 and 6 points of the meridian; then the error may be either in the courfe or in the diftance, or in both, which

**PRACTICE** which will cause an error both in the difference of latitude and departure; to correct which, having found the true difference of latitude by observation, with this, and the direct distance by dead reckoning, find a new departure (by *Case 3. of Plane Sailing*;) then half the sum of this departure, and that by dead reckoning, will be nearly equal to the true departure; and consequently with this, and the true difference of latitude, we may (by *Case 4. of Plane Sailing*) find the true course and distance.

**EXAMPLE.** Suppose a ship from the latitude of  $44^{\circ} 38'$  north, sails between four and east upon several courses, near the middle of the quadrant, for the space of 24 hours, and is then found by dead reckonings to be in the latitude of  $42^{\circ} 15'$  north, and to have made of sailing 136 miles; but by observation she is found to be in the latitude of  $42^{\circ} 04'$  north: Required her true course and distance.

With the true distance of latitude 154 miles, and the direct distance by dead reckoning 197.4, you will find (by *Case 3. of Plane Sailing*) the new departure to be 123.4, and half the sum of this and the departure by dead reckoning will be 123.7 the true departure; then with this, and the true difference of la-

titude, you will find (by *Case 4. of Plane Sailing*), **PRACTICE** the true course to be  $S. 39^{\circ} 00' E.$  and the direct distance 198.2 miles.

7. In keeping a ship's reckoning at sea, the common method is to take from the log-board the several courses and distances sailed by the ship last 24 hours, and to transfer these together with the most remarkable occurrences into the log-book, into which also are inserted the courses corrected, and the difference of latitude and difference of longitude made good upon each; then the whole day's work being finished in the log-book, if the latitude by account agree with the latitude by observation, the ship's place will be truly determined; if not, then the reckoning must be corrected according to the preceding rules, and placed in the journal.

The form of the Log-book and Journal, together with an example of 2 days work, you have here subjoined.

Note, to express the days of the week, they commonly use the characters by which the sun and planets are expressed, *viz.*  $\odot$  denotes Sunday,  $\text{M}$  Monday,  $\text{T}$  Tuesday,  $\text{W}$  Wednesday,  $\text{Th}$  Thursday,  $\text{F}$  Friday, and  $\text{S}$  denotes Saturday.

§ 11. *The Form of the Log-Book, with the Manner of working Days Works at Sea.*

The Log-Book.					
H.	K.	1/2 K.	Courses.	Winds.	Observations and Accidents. D.— Day of —
1					Fair weather, at four this afternoon
2				North	I took my departure from the Lizard, in the latitude of $5^{\circ} 00'$ north, it bearing NNE, distance five leagues.
3					
4			SW $\frac{1}{2}$ S	N $\frac{1}{2}$ E	
5					
6					
7					
8					
9					
10					
11			SSW	E $\frac{1}{2}$ S	The gale increasing and being under all our sails.
12					After three this morning, frequent showers with thick weather till near noon.
1			SW $\frac{1}{2}$ W	NNE	
2					
3					
4					
5					
6					
7					
8			SW	ENE	The variation I reckon to be one point westerly.
9					
10					
11			SW $\frac{1}{2}$ W	NE $\frac{1}{2}$ E	
12					

The Log-Book.						
Courses	Correct.	Dist.	Diff. Lat.		Diff. Long.	
			N.	S.	E.	W.
8 SW		50		46.2		29.4
S $\frac{1}{2}$ W		19		18.6		5.5
S W		49		29.7		45.5
S W $\frac{1}{2}$ S		24.5		20.2		20.0
S W $\frac{1}{2}$ S		25.5		19.5		24.6
				144.2		125.0

Hence the ship, by account, has come to the latitude of  $47^{\circ} 46'$  north, and has differed her longitude  $2^{\circ} 5'$  westerly; so this day I have made my way good  $S. 31^{\circ} 31' W.$  distance 157.4 miles.

At noon the Lizard bore from me  $N. 31^{\circ} 31' E.$  distance 157.4 miles; and having observed the latitude, I found it agreed with the latitude by account.

The Log-Book.				
H.K.	K.	Courfes.	Winds.	Observations and Accidents & Day of
1	2		SSW W	This 24 hours, strong gale of wind and variable.
2	1	1	Handed the main and fore courfes,	
3	1	1	lee-way 6 points.	
4	1	1		
5	1	1		The variation I judge to be 1 point west.
6	1			
7	1			
8	1	1	The wind increasing, we tried a haul, lee-way 7 points.	
9	1			The variation I judge to be 1 point west.
10	1			
11	1	1		
12	1	1		
1	2		SW $\delta$ W NW $\delta$ W	Set main-fail, lee-way 4 $\frac{1}{2}$ points.
2	1	1		
3	1			
4	1			
5	1			Lat. by observation, 47° 06' N.
6	1	1		
7	1			
8	4		S $\delta$ E SW $\delta$ W	
9	4	1	Set fore-fail, lee-way 3 points.	
10	4	1		
11	5			
12	4	1		

The Log-Book.						
Courfes	Correct.	Diff.	Diff. Lat.		Diff. Long.	
			N.	S.	E.	W.
S E $\delta$ E		32.5		17.8	37.7	
E S E		6		2.3	10.6	
S $\frac{1}{2}$ E		9		8.9	1.3	
				29.0	49.6	

Hence the ship, by account, has come to the latitude of 47° 17' north, and has differed her longitude 49' easterly; consequently she has got 1° 16' to the westward of the Lizard, and has made her way good the last 24 hours 849° 08' E, distance 44.3 miles.

At noon the Lizard bore from me north 17° 7' east, distance 170.6 miles.

This day I had an observation, and found the latitude by account to disagree with the latitude by observation by 11 minutes, I being so much further to the southward than by dead reckoning, which by the third of the preceding rules I correct as in the Journal.

A JOURNAL from the Lizard towards Jamaica in the ship Neptune, J. M. commander.

Week Days.	Months Years.	Month Days.	Winds.	Direct Courfe.	Diff. Miles	Latitude Correct.	Whole Diff. Long. made.	Bearing and Diff. from the Lizard.	Remarkable Observations and Accidents.
D			N $\delta$ E E $\delta$ S NNE ENE NE $\delta$ E	S 31, 31 W	157.4	47°, 46'	2°, 5' W	At noon the Lizard bore N. 31° 31' E. Diff. 157.4 miles.	Fair weather at four P.M. I took my departure from the Lizard, it bearing NNE distance 5 leagues.
$\delta$			West NW $\delta$ W SW $\delta$ W	S 34, 01 E	8.2	47°, 06'	1°, 55' W	At noon the Lizard bore S. 17° 55' W. Diff. 183 miles.	Strong gales of wind and variable.

Navigation

Nautilus.

Inland NAVIGATION. See CANAL, and TRADE.

NAUMACHIA, in antiquity, a show or spectacle among the ancient Romans, representing a sea-fight.

NAUMBURG, a town of Germany, in the circle of Upper Saxony, capital of the county of Saxe-Naumburg, situated on the river Sala, in E. Long. 11. 20. N. Lat. 51. 12.

NAUPACTUS, or NAUPACTUM, (anc. geogr.), the extreme or outmost town of the Ætolians, formerly belonging to the Locrians, but adjudged by Philip to the former: so called from the shipbuilding there carried on, and situated near Antirrhium on the Corinthian bay. *Naupaflus*, the epithet. Now *Le-panto*, a port-town of Achaia or Livadia, on the north side of the gulf of that name. E. Long. 22. 20. N. Lat. 38. 0.

NAUPORTUS, or NAUPORTUM, (anc. geogr.), a town on a cognominal river, towards its source, in Pannonia Superior. The reason of the name, according to Pliny, is, that the ship *Argo*, after coming up the Danube, the Save, and the Laubach, was thence carried on men's shoulders over the Alps into the Adriatic. The river Nauportus rises in the Alps, near Longaticum, at the distance of six miles from the town Nauportum; which was a colony of the Taurisci, a people on the confines of Noricum. Now *Upper Laubach* in Carinthia, on the river Laubach. E. Long. 14. 40. N. Lat. 46. 28.

NAUSEA, or SICKNESS; a retching or propensity and endeavour to vomit, arising from something which irritates the stomach.

NAUTILUS, in zoology, a genus belonging to the order of vermes testacea. The shell consists of one spiral valve, divided into several apartments by partitions. There are 17 species, chiefly distinguished by particularities in their shells.

Bonani observes, that this genus of shell-fish is very well named from the Greek *ναυτια*, which signifies both "a ship," and "a sailor;" for that the shells of all the nautili carry the appearance of a ship with a very high poop. Different authors, both ancient and modern, have called the nautilus by the names of *pompilus*, *nauplius*, *nauticus*, *ovum polyphi*, *polypus testaceus*; and the French call it *le volier*. It is by some imagined, that men first learned the art of navigation from this animal. See *HISTORY OF NAVIGATION*.

The most remarkable division of the nautili is into the thin and thick-shelled kinds. The first is called *nautilus papyraceus*; and its shell is indeed no thicker than a piece of paper when out of the water. This species is not at all fastened to its shell; but there is an opinion, as old as the days of Pliny, that this creature creeps out of its shell, and goes on shore to feed. When this species is to fail, it expands two of its arms on high, and between these supports a membrane, which it throws out on this occasion: this serves for its sail, and the two other arms it hangs out of its shell, to serve occasionally either as oars or as a steering; but this last office is generally served by the tail.

When the sea is calm, it is frequent to see numbers of these creatures diverting themselves in this manner: but as soon as a storm rises, or any thing gives them disturbance, they draw in their legs, and take in as much water as makes them specifically heavier than

that in which they float; and then they sink to the bottom. When they rise again, they void this water by a number of holes, of which their legs are full. The other nautilus, whose shell is thick, never quits that habitation. This shell is divided into 40 or more partitions, which grow smaller and smaller as they approach the extremity or centre of the shell: between every one of these cells and the adjoining ones there is a communication by means of a hole in the centre of every one of the partitions. Through this hole there runs a pipe of the whole length of the shell. It is supposed by many, that by means of this pipe the fish occasionally passes from one cell to another; but this seems by no means probable, as the fish must undoubtedly be crushed to death by passing through it. It is much more likely that the fish always occupies the largest chamber in its shell; that is, it lives in the cavity between the mouth and the first partition, and that it never removes out of this; but that all the apparatus of cells, and a pipe of communication which we so much admire, serves only to admit occasionally air or water into the shell, in such proportion as may serve the creature in its intentions of swimming.

Some authors call this shell the *concha margaritifera*: but this can be only on account of the fine colour on its inside, which is more beautiful than any other mother-of-pearl; for it has not been observed that this species of fish ever produced pearls. It must be observed, that the polyypus is by no means to be confounded with the paper-shelled nautilus, notwithstanding the great resemblance in the arms and body of the inclosed fish; nor is the cornu ammonis, so frequently found fossil, to be confounded with the thick-shelled nautilus, though the concamerations and general structure of the shell are alike in both; for there are great and essential differences between all these genera.

NAVY, the fleet or shipping of a prince or state. See MARINE.

The management of the British navy-royal under the lord high admiral of Great Britain, is entrusted to principal officers and commissioners of the navy, who hold their places by patent. The principal officers of the navy are four, viz. the treasurer, whose business it is to receive money out of the exchequer, and to pay all the charges of the navy, by warrant from the principal officers: comptroller, who attends and controuls all payment of wages, is to know the rates of stores, to examine and audit all accounts, &c.: surveyor, who is to know the rates of all stores, and see wants supplied; to estimate repairs, charge boat-swains, &c. with what stores they receive, and at the end of each voyage to state and audit accounts: clerk of the acts, whose business it is to record all orders, contracts, bills, warrants, &c.

The commissioners of the navy are five: the first executes that part of the comptroller's duty which relates to the comptrolling the victualler's accounts; the second, another part of the said comptroller's duty relating to the account of the storekeepers of the yard; the third has the direction of the navy at the port of Portsmouth; the fourth has the same at Chatham; and the fifth at Plymouth. There are also other commissioners at large, the number more or less

Nautilus,  
Navy.

Navy  
Naxus.

Nazarenus  
Neapolis.

less according to the exigencies of public affairs; and since the increase of the royal navy, these have several clerks under them, with salaries allowed by the king.

The victualling of the royal navy hath formerly been undertaken by contract; but is now managed by commissioners, who hold their office on Tower-hill, London. The navy-office is where the whole business concerning the navy is managed by the principal officers and commissioners.

The royal navy of Great Britain is now in a very flourishing state, having been diligently kept up in late reigns, as the natural strength of the kingdom. When it is complete, it is divided into three squadrons, distinguished by the colours of the flags carried by the respective admirals belonging to the same, viz. red, white, and blue; the principal commander of which bears the title of *admiral*; and each has under him a vice-admiral and a rear-admiral, who are likewise flag-officers.

Navy-Exercise. See EXERCISE.

Navy-Discipline or Regulations. See MARITIME State.

NAXIA, or NAXOS, a considerable island of the Archipelago, 25 miles in length, and 88 in circumference. The whole island is covered with orange, olive, lemon, cedar, citron, pomegranate, fig, and mulberry-trees; and there are a great many springs and brooks. This island has no harbour; and yet they carry on a considerable trade in barley, wine, figs, cotton, silk, flax, cheese, salt, oxen, sheep, mules, and oil. They burn only oil of mastic, though olive-oil is exceeding cheap. It is inhabited both by Greeks and Latins, who live in great dread of the Turks: for when the men of their ships appear here, they always wear red caps like galley-slaves, and tremble before the lowest officer; but, as soon as they are gone, they put on their caps of velvet. The ladies are so vain, that, when they return out of the country, they have 40 women in their train, half on foot and half on asses, one of whom carries a napkin or two, another a petticoat, another a pair of stockings, and so on; which is a very ridiculous sight to strangers. There are four archbishops sees in this island, and a great many villages; but so thin of people, that the whole island does not contain above 8000 inhabitants. The highest mountain is *Zia*, which signifies "the mountain of Jupiter." There are but few antiquities, except some small remains of the temple of Bacchus. Some say they have mines of gold and silver; however, there is one of emery, which is so common here, and so cheap, that the English often ballast their ships therewith.

NAXOS, or *Naxia*, a considerable town, and capital of the isle of Naxos, over-against the isle of Paros, with a castle and two archbishops sees, the one Greek and the other Latin. The greatest part of the inhabitants are Greeks. E. Long. 25. 51. N. Lat. 37. 8.

NAXUS (anc. geogr.), the most remarkable of the Cyclades, 18 miles to the east of Delos; called *Strongyle*, then *Dia*, and *Dionysias*. Some have called it *Sicily lesa*. Now called *Naxia*, *Nixia*, or *Naxos*. E. Long. 26. 5. N. Lat. 36. 30.

NAXUS (anc. geogr.), a town of Crete, famous for its honey, called *Lapis Naxius*. Another of Sicily,

built by the Chalcidian; situate on the south side of Mount Taurus, destroyed by Dionysius the tyrant; from whose ruins Tauroumenium, built by Timoleon, either arose or was recreated, (Plutarch).

NAZARENES, in church-history, a name originally given to all Christians in general, on account that Jesus Christ was of the city of Nazareth; but afterwards restrained to a set of heretics, whose religion consisted of a strange jumble of Judaism and Christianity, observing at the same time the Mosaic law, and the rites of the Christian religion.

NAZARETH (anc. geogr.), a town of Galilee near mount Tabor, situate on an eminence; the place of the annunciation or conception of our Saviour, and of his residence till he entered on his public ministry at 30 years of age.

NAZARITES, among the Jews, persons who, either of themselves, or by their parents, were dedicated to the observation of Nazarethship. They were of two sorts; namely, such as were bound to this observance only for a short time, as a week or a month; or those who were bound to it all their lives. All that were peculiar in the latter's way of life is, that they were to abstain from wine and all intoxicating liquors, and never to shave or cut off the hair of their heads. The first sort of Nazarites were, moreover, to avoid all defilement; and if they chanced to contract any pollution before the term was expired, they were obliged to begin afresh. Women as well as men might bind themselves to this vow.

NAZIANZEN. See GREGORY Nazianzen.

NEALED, among seamen, is used when the sounding is deep water close to the shore; as also when the shore is sandy, clayey, oozy, or foul and rocky ground.

NEALING, or rather ANNEALING, a term used for the preparing of several matters, by heating or baking them in the oven, or the like.

NEALED. When a ship wants water, so that she cannot get out of the harbour, off the ground, or out of the dock, the seamen say she is *neaped*, or *be-neaped*.

NEAPOLIS (anc. geogr.), a city of the Higher Egypt, in the Nomos Panopolitanus, between Thebes to the south, and Panopolis to the north, on the east side of the Nile. Otherwise called *Caena*.—A second Neapolis of Babylonia, situate near the Euphrates, on the south side.—A third of Campania, an ancient town, and a colony from Cumæ, called at first *Parthenope*, from the tomb of the sire of that name, (Velleius, Pliny, Strabo); accounted a Greek city, and a great stickler for Greek usages, (Livy, Tacitus). Its hot baths were in nothing inferior to those of Baie, according to Strabo: at two miles distance from it stands the monument of Virgil, held in religious veneration by learned posterity. The Younger Pliny relates, that Virgil's birthday was more religiously observed by Silius Italicus than his own, especially at Naples, where he resorted to his tomb as to a temple. The city is washed by river Sebethus. Virgil feigns the nymph Sebethis to prelude over the stream. Now *Naples*, capital of the kingdom of that name; E. Long. 15. 12. N. Lat. 41. 6.—A fourth, Neapolis of Caria, near the Meander, (Ptolemy).—A fifth, an inland town of Cyrenaica, situate between Ptolemais and Arinoo, (Ptolemy);

Next  
Necessity.

lemy); and to be distinguished from the Cœnopolis, or Neapolis, on the east border of the same province, (id.).—A sixth, of Ionia, (Strabo); which belonged first to the Ephesians, but afterwards to the Samians, who exchanged Marathesium, a more distant city, for a nearer.—A seventh, Neapolis of Macedonia Adjecta, situate at the distance of 12 miles to the east of Philippi, (Antonine).—An eighth, Neapolis of Pifidia, on the borders of Galatia, situate between Amblada and Pappa, (Ptolemy).—A ninth, of Samaria, the ancient *Sichem*, which see; so called upon its restoration by the Romans, (Coin, Pliny, Josephus).—A tenth, of Sardinia, situate on the south-west side of the island, 30 miles to the north of Metalla: now called *Neapoli*.—An eleventh, of the Regio Syrtica, called also *Leptis*.—A twelfth, of Zeugitana on the Mediterranean, to the east of Clypea, and south of the Promontorium Mercnrii.

NEAT or NET *Weight*, the weight of a commodity alone, clear of the cask, bag, case, or even fifth. See NET.

NEBIO, or NEBBIO, a ruined city of Italy, on the north side of the island of Corsica, with a bishop's see, whose bishop resides at San Florenzo, from which it is a mile distant.

NEBO (anc. geogr.), a very high mountain, a part of the mountains Abarim, and their highest top, whither Moses was ordered to ascend to take a view of the land of Canaan, and there die. Situate in the land of Moab, over-against Jericho: with a cognominal town at its foot (Itajah) belonging to the Reubenites, which afterwards returned to the Moabites; in Jerome's time desolate; eight miles to the south of Hebron.

NEBUCHADNEZZAR. See NABUCHADNEZZAR.

NEBULY, or NEBULEE, in heraldry, is when a coat is charged with several little figures, in form of words running within one another, or when the outline of a bordure, ordinary, &c. is indented or waved.

NECESSITY, whatever is done by a necessary cause, or a power that is irresistible; in which sense it is opposed to freedom. See METAPHYSICS, n<sup>o</sup> 78—80.

NECESSITY, in law, as it implies a defect of will, excuses from the guilt of crimes. See CRIME.

*Compulsion* and inevitable *necessity* are a constraint upon the will, whereby a man is urged to do that which his judgment disapproves; and which, it is to be presumed, his will (if left to itself) would reject. As punishments are therefore only inflicted for the abuse of that free-will which God has given to man, it is highly just and equitable that a man should be excused for those acts which are done through unavoidable force and compulsion.

1. Of this nature, in the first place, is the obligation of *civil subjection*, whereby the inferior is constrained by the superior to act contrary to what his own reason and inclination would suggest: as when a legislator establishes iniquity by a law, and commands the subject to do an act contrary to religion or sound morality. How far this excuse will be admitted *in foro conscientie*, or whether the inferior in this case is not bound to obey the divine rather than the hu-

man law, it is not our business to decide; though, among the casuists, it is believed the question will hardly bear a doubt. But, however that may be, obedience to the laws in being is undoubtedly a sufficient extenuation of civil guilt before the municipal tribunal. The sheriff who burnt Latimer and Ridley in the bigotted days of queen Mary, was not liable to punishment from Elizabeth for executing so horrid an office; being justified by the commands of that magistracy which endeavoured to restore Superstition, under the *holy* auspices of its merciless filter, Perfection.

As to persons in private relations, the principal case where constraint of a superior is allowed as an excuse for criminal misconduct, is with regard to the matrimonial subjection of the wife to her husband: for neither a son or a servant are excused for the commission of any crime, whether capital or otherwise, by the command or coercion of the parent or master; though in some cases the command or authority of the husband, either express or implied, will privilege the wife from punishment, even for capital offences. And therefore if a woman commit theft, burglary, or other civil offences against the laws of society, by the coercion of her husband, or even in his company, which the law construes a coercion, she is not guilty of any crime; being considered as acting by compulsion, and not of her own will. Which doctrine is at least 1000 years old in this kingdom, being to be found among the laws of king Ina the West-Saxon. And it appears, that, among the northern nations on the continent, this privilege extended to any woman transgressing in concert with a man, and to any servant that committed a joint offence with a freeman: the male or freeman only was punished, the female or slave dismissed; "*procul dubio quod alterum libertas, alterum necessitas impelleret.*" But (besides that, in our law, which is a stranger to slavery, no impunity is given to servants, who are as much free agents as their masters) even with regard to wives, this rule admits of an exception in crimes that are *mala in se*, and prohibited by the law of nature; as murder, and the like: not only because these are of a deeper dye; but also, since in a state of nature no one is in subjection to another, it would be unreasonable to screen an offender from the punishment due to natural crimes, by the refinements and subordinations of civil society. In treason also, (the highest crime which a member of society can, as such, be guilty of), no plea in coverture shall excuse the wife; no presumption of the husband's coercion shall extenuate her guilt: as well because of the odiousness and dangerous consequence of the crime itself, as because the husband, having broken through the most sacred tie of social community by rebellion against the state, has no right to that obedience from a wife, which he himself as a subject has forgotten to pay. In inferior misdemeanors also, we may remark another exception, that a wife may be indicted and set in the pillory *with* her husband, for keeping a brothel: for this is an offence touching the domestic economy or government of the house, in which the wife has a principal share; and is also such an offence as the law presumes to be generally conducted by the intrigues of the female sex. And in all cases where the wife offends alone, without the com-

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Necessity. pany or coercion of her husband, she is responsible for her offence as much as any female.

2. Another species of compulsion or necessity is what our law calls *dureſſe per minas*; or threats and menaces, which induce a fear of death or other bodily harm, and which take away for that reason the guilt of many crimes and misdemeanors, at least before the human tribunal. But then that fear which compels a man to do an unwarrantable action ought to be just and well-grounded: such, "*qui cadere poſſit in virum conſtantem, non timidum et meticuloſum,*" as Bracton expreſſes it, in the words of the civil law. Therefore, in time of war or rebellion, a man may be juſtified in doing many reaſonable acts by compulſion of the enemy or rebels, which would admit of no excuſe in the time of peace. This, however, ſeems only, of at leaſt principally, to hold as to poſitive crimes, ſo created by the laws of ſociety, and which therefore ſociety may excuſe; but not as to natural offences, ſo declared by the law of God, wherein human magiſtrates are only the executioners of divine puniſhment. And therefore though a man be violently aſſaulted, and hath no other poſſible means of eſcaping death but by killing an innocent perſon, this fear and force ſhall not acquit him of murder; for he ought rather to die himſelf than eſcape by the murder of an innocent. But in ſuch a caſe he is permitted to kill the aſſailant; for there the law of nature, and ſelf-defence its primary canon, have made him his own proteſtor.

3. There is a third ſpecies of neceſſity, which may be diſtinguiſhed from the actual compulſion of external force or fear; being the reſult of reaſon and reflection, which act upon and conſtrain a man's will, and oblige him to do an action which without ſuch obligation would be criminal. And that is, when a man has his choice of two evils ſet before him, and being under a neceſſity of chooſing one, he chooſes the leaſt pernicious of the two. Here the will cannot be ſaid freely to exert itſelf, being rather paſſive than active; or, if active, it is rather in rejecting the greater evil than in chooſing the leſs. Of this ſort is that neceſſity, where a man by the commandment of the law is bound to arreſt another for any capital offence, or to diſperſe a riot, and reſiſtance is made to his authority: it is here juſtifiable, and even neceſſary, to beat, to wound, or perhaps to kill, the offenders, rather than permit the murderer to eſcape, or the riot to continue. For the preſervation of the peace of the kingdom, and the apprehending of notorious malefactors, are of the utmoſt conſequence to the public; and therefore excuſe the felony, which the killing would otherwiſe amount to.

4. There is yet another caſe of neceſſity, which has occaſioned great ſpeculation among the writers upon general law; *viz.* whether a man in extreme want of food or clothing may juſtify ſtealing either, to relieve his preſent neceſſities. And this both Grotius and Puffendorf, together with many other of the foreign jurists, hold in the affirmative; maintaining by many ingenious, humane, and pleaſible reaſons, that in ſuch caſes the community of goods, by a kind of tacit conſenſion of ſociety, is revived. And ſome even of our lawyers have held the ſame; though it ſeems to be an unwarranted doctrine, borrowed from the notions of ſome civilians: at leaſt it is now antiquated, the law of England admitting no ſuch excuſe at preſent. And

this its doctrine is agreeable not only to the ſentiments of many of the wiſeſt ancients, particularly Cicero, who holds, *That ſuum cuique incommodum ferendum eſt, potius quam de alterius commodis detrabendum*; but alſo to the Jewiſh law, as confirmed by king Solomon himſelf: "If a thief ſteal to ſatiſfy his ſoul when he is hungry, he ſhall reſtore ſevenfold, and ſhall give all the ſubſtance of his houſe:" which was the ordinary puniſhment for theft in that kingdom. And this is founded upon the higheſt reaſon: for mens properties would be under a ſtrange infeſcurity, if liable to be invaded according to the wants of others; of which wants no man can poſſibly be an adequate judge, but the party himſelf who pleads them. In England eſpecially, there would be a peculiar impropriety in admitting ſo dubious an excuſe: for by the laws ſuch ſufficient provision is made for the poor by the power of the civil magiſtrate, that it is impoſſible that the moſt needy ſtranger ſhould ever be reduced to the neceſſity of thieving to ſupport nature. The caſe of a ſtranger is, by the way, the ſtrongeſt inſtance put by baron Puffendorf, and whereon he builds his principal arguments: which, however they may hold upon the continent, where the pariſimonious indolence of the natives orders every one to work or ſtarve, yet muſt loſe all their weight and efficacy in England, where charity is reduced to a ſyſtem, and interwoven in our very conſtitution. Therefore our laws ought by no means to be taxed with being unmerciful, for denying this privilege to the neceſſitous; eſpecially when we conſider, that the king, on the repreſentation of his miniſters of juſtice, hath a power to ſoften the law, and to extend mercy in caſes of peculiar hardſhip. An advantage which is wanting in many ſtates, particularly thoſe which are democratical: and theſe have in its ſtead introduced and adopted, in the body of the law itſelf, a multitude of circumſtances tending to alleviate its rigour. But the founders of our conſtitution thought it better to veſt in the crown the power of pardoning particular objects of compaſſion, than to countenance and eſtabliſh theft by one general undiſtinguiſhing law.

NECHO, king of Egypt, began his reign 69 B. C. and was killed eight years after by Sabacon king of Ethiopia. Pſammiticus his ſon ſucceeded him, and was the father of Necho II. who reigned in the 616 B. C. This Necho II. is celebrated in hiſtory for attempting, though in vain, to cut a canal from the Nile to the Arabian gulf. He ſent the Phœnicians to ſail round Africa by ſea, defeated Joſias and the Babylo-nians, and gained many victories; but he was conquered in his turn by Nebuchadnezzar, who confined him within his ancient kingdom.

NECK, in anatomy, is that ſlender part ſituated between the head and trunk of the body. See ANATOMY, n<sup>o</sup> 30.

NECROMANCY, or NEGROMANCY, a ſpecies of divination performed by raiſing the dead, and extorting answers from them. See DIVINATION.

NECTAR, among ancient poets, the drink of the fabulous deities of the heathens; in contradiſtinction from their ſolid food, which was called *ambroſia*.

NECTARINE, a fruit diſſering in nothing from the common peach, of which it is a ſpecies, than in having a ſmoother rind and a firmer pulp. See PERSICA.

NECTARIUM, from *nectar*, the fabled "drink  
of

Necho  
Nectarium.

**Nectarium.** of the gods;" defined by Linnæus to be a part of the corolla, or appendage to the petals, appropriated for containing the honey, a species of vegetable salt under a fluid form, that oozes from the plant, and is the principal food of bees and other insects.

Notwithstanding this definition, which seems to consider the nectarium as necessary a part of the corolla as the petals; it is certain that all flowers are not provided with this appendage, neither indeed is it essential to fructification.

Milne's  
Bot. Diff.

There is, besides, a manifest impropriety in terming the nectarium a part of the corolla. Linnæus might, with equal propriety, have termed it a part or appendage of the stamina, calix, or pointal, as the appearance in question is confined to no particular part of the flower, but is as various in point of situation as of form. The truth is, the term *nectarium* is exceedingly vague; and, if any determinate meaning can be affixed to it, is expressive of all the singularities which are observed in the different parts of flowers.

The tube, or lower part of flowers with one petal, Linnæus considers as a true nectarium, because it is generally found to contain the sweet liquor formerly mentioned. This liquor Pontederia compares to that called *amnios* in pregnant animals, which enters the female or impregnated feeds: but that this is not at least its sole use, is evident from this circumstance, that the honey or liquor in question is to be found in flowers where there are either no seeds, or those, from the want of male organs, cannot be impregnated. Thus the male flowers of nettle and willow; the female flowers of sea-side laurel and black bryony; the male and female flowers of clutia, higgelaria, and butcher's broom, all abound with the honey or nectar alluded to.

Dr Vaillant was of opinion, that the nectarium was an essential part of the corolla; for which reason he distinguished the singular appearances in fennel-flower and columbine, by the name of *petals*: the coloured leaves which are now termed the *petals*, he denominates the *flower-cup*.

That the nectarium, however, is frequently distinct from the petals, is evident, both from the well-known examples just mentioned, as likewise from the flowers of monkhood, hellebore, fipopyrum, fennel-flower of Crete, barrenwort, grass of Parnassus, chocolate-nut, cherleria, and saugafia.

These general observations being premised, we proceed to take a nearer and more particular view of the principal diversities, both in form and situation, of this striking appendage to the flower. 1. In many flowers the nectarium is shaped like a spur or horn; and that either in flowers of one petal, as valerian, water-milfoil (*articularia*), butter-wort, and calves-foot; or in such as have more than one, as lark-spur, violet, fumatory, balsam, and orchis. 2. In the following plants, the nectarium is properly a part of the corolla, as lying within the substance of the petals: ranunculus, lily, iris, crown-imperial, water-leaf, mouse-tail, a-nanas or pine-apple, dog's-tooth violet, piperidge bush, wallinera, hermannia, uvularia, and swertia. 3. The nectarium is frequently placed in a series or row within the petals, though entirely unconnected with their substance. In this situation it often resembles a cup, as in narcissus. A nectarium of this kind is said by

Linnæus to crown the corolla. The following are examples: daffodil, sea-daffodil, campion, viscous campion, swallow-wort, stapelia, cynanchum, nepenthes, cherleria, balsam-tree, African spiræa, witch-hazel, olax, and passion-flower. 4. In Indian cresfs, buckler mustard, Barbadoes cherry, and monotropa, the nectarium is situated upon or makes part of the calix. 5. The nectarium in bastard flower-fence is seated upon the antheræ or tops of the stamina; whence the name *adenanthera*, or *glandular anthera*, which has been given to this genus of plants. In the following list it is placed upon the filaments: bean-caper, bay, fraxinella, marvel of Peru, bell-flower, lead-wort, roëlla, and comeliina. 6. In hyacinth, flowering-rush, stock July-flower, and rocket, the nectarium is placed upon the seed-bud. 7. In honey-flower, orpine, buck-wheat, collinsonia, lathræa, navel-wort, mercury, clutia, kiggelaria, sea-side laurel, and African spiræa, it is attached to the common receptacle. Lastly, in ginger, nettle, dyer's weed, heart-leaf, costus, turmeric, grewia, bastard orpine, vanellæ, skrew-tree, and willow, the nectarium is of a very singular construction, and cannot properly fall under any of the foregoing heads.

In discriminating the genera, the nectarium often furnishes an essential character.

Plants which have the nectarium distinct from the petals, that is, not lodged within their substance, are affirmed by Linnæus to be generally poisonous. The following are adduced as examples: monk's hood, hellebore, columbine, fennel-flower, grass of Parnassus, barren-wort, oleander, marvel of Peru, bean-caper, succulent swallow-wort, fraxinella, and honey-flower.

**NECYDALIS**, in zoology, a genus of insects belonging to the order of coleoptera. The feelers are setaceous; the elytra are shorter and narrower than the wings; the tail is simple. There are 11 species, chiefly distinguished by the size and figure of their elytra.

**NEEDLE**, a very common little instrument or utensil, made of steel, pointed at one end, and pierced at the other, used in sewing embroidery, tapestry, &c.

Needles make a very considerable article in commerce, though there is scarce any commodity cheaper, the consumption of them being almost incredible. The sizes are from n<sup>o</sup> 1. the largest, to n<sup>o</sup> 25. the smallest. In the manufacture of needles, German and Hungarian steel are of most repute.

In the making of them, the first thing is to pass the steel through a coal-fire, and under a hammer, to bring it out of its square figure into a cylindrical one. This done, it is drawn through a large hole of a wire-drawing iron, and returned into the fire, and drawn thro' a second hole of the iron, smaller than the first; and thus successively from hole to hole, till it has acquired the degree of fineness required for that species of needles; observing every time it is to be drawn, that it be greased over with lard, to render it more manageable. The steel thus reduced to a fine wire, is cut in pieces of the length of the needles intended. These pieces are flatted at one end on the anvil, in order to form the head and eye: they are then put into the fire, to soften them farther; and thence taken out and pierced at each extreme of the flat part on the anvil, by force of a punchon of well-tempered steel, and laid on a leaden block to bring out, with another punchon,



cheon, the little piece of steel remaining in the eye. The corners are then filed off the square of the heads, and a little cavity filed on each side of the flat of the head; this done, the point is formed with a file, and the whole filed over: they are then laid to heat red-hot on a long narrow iron, crooked at one end, in a charcoal fire; and when taken out thence, are thrown into a basin of cold water to harden. On this operation a good deal depends; too much heat burns them, and too little leaves them soft: the medium is learned by experience. When they are thus hardened, they are laid in an iron shovel on a fire more or less brisk in proportion to the thickness of the needles; taking care to move them from time to time. This serves to temper them, and take off their brittleness; great care here too must be taken of the degree of heat. They are then straightened one after another with the hammer, the coldness of the water used in hardening them having twisted the greatest part of them.

The next process is the polishing them. To do this, they take 12,000 or 15,000 needles, and range them in little heaps against each other on a piece of new buckram sprinkled with emery-dust. The needles thus disposed, emery-dust is thrown over them, which is again sprinkled with oil of olives; at last the whole is made up into a roll, well bound at both ends. This roll is then laid on a polishing table, and over it a thick plank laden with stones, which two men work backwards and forwards a day and a half, or two days, successively; by which means, the roll thus continually agitated by the weight and motion of the plank over it, the needles within being rubbed against each other with oil and emery, are insensibly polished. After polishing, they are taken out, and the filth washed off them with hot water and soap: they are then wiped in hot bran, a little moistened, placed with the needles in a round box, suspended in the air by a cord, which is kept stirring till the bran and needles be dry. The needles thus wiped in two or three different brans, are taken out and put in wooden vessels, to have the good separated from those whose points or eyes have been broke either in polishing or wiping; the points are then all turned the same way, and smoothed with an emery-stone turned with a wheel. This operation finishes them, and there remains nothing but to make them into packets of 250 each.

*Dipping Needle, or Inclinary Needle*, a magnetic needle, so hung, as that, instead of playing horizontally, and pointing out north and south, one end dips, or inclines to the horizon, and the other points to a certain degree of elevation above it.

The dipping-needle was invented in the year 1576, by one Robert Norman a compass-maker at Wapping. The occasion of the discovery, according to his own account was, that it being his custom to finish and hang the needles of his compasses before he touched them, he always found, that immediately after the touch, the north-point would bend or incline downward, under the horizon; inasmuch that, to balance the needle again, he was always forced to put a piece of wax on the south-end as a counterpoise. The constancy of this effect led him at length to observe the precise quantity of the dip, or to measure the greatest angle which the needle would make with the horizon; and this at London he found to be  $71^{\circ} 50'$ . In 1723

Mr Graham made a great many observations on the dipping-needle, and found the angle to be between  $74$  and  $75$  degrees. Mr Nairne, in 1772, found it to be somewhat above  $72^{\circ}$ . It is not certain whether the dip varies, as well as the horizontal direction, in the same place. The trifling difference between Mr Forman and Mr Nairne, would lead us to imagine that the dip was unalterable; but Mr Graham, who was a very accurate observer, makes the difference more considerable. It is certain, however, from a great number of experiments and observations, that the dip is variable in different latitudes, and that it increases in going northwards. It appears from a table of observations made with the marine dipping-needle in a voyage towards the north pole, in 1773, that in lat.  $60. 18$ . the dip was  $75^{\circ}$ ; and in lat  $70. 45$ . it was  $77^{\circ} 52'$ ; in lat.  $80. 12$ . it was  $81^{\circ} 52'$ ; and in lat.  $80. 27$ . it was  $82^{\circ} 23'$ .

Several authors have endeavoured to apply this discovery of the dip to the finding of the latitude; and Mr Bond attempted to apply it to the finding of the longitude also; but for want of observations and experiments, he could not make any progress. The affair was farther prosecuted by Mr Whitton, who published a treatise on the longitude, and for some time imagined it was possible to find it exactly by means of the dip of the needle; yet he at last despaired of it, for the following reasons: 1. The weakness of the magnetic power. 2. The concussion of the ship, which he found it exceeding difficult to avoid so much as was necessary for the accuracy of the experiments. 3. The principal objection was an irregularity in the motions of all magnetic needles, both horizontal and dipping, by which they, within the compass of about a degree, vary uncertainly backward and forward; even sometimes, in a few hours time, without any evident cause. For a particular account of these variations both of the horizontal and dipping needle, see the article VARIATION.

Mr Nairne, an ingenious instrument-maker in London, made a dipping-needle in 1772 for the board of longitude, which was used in the voyage towards the north-pole. This is represented Plate CCIV. fig. 1. The needle AA is 12 inches long, and its axis, the ends BB of which are made of gold alloyed with copper, rests on friction-wheels CCCC, of four inches diameter, each end on two friction-wheels; which wheels are balanced with great care. The ends of the axes of the friction-wheels, are likewise of gold alloyed with copper, and moved in small holes made in bell-metal; and opposite to the ends of the axes of the needle, and the friction-wheels, are flat agates, set in at DDD, finely polished. The magnetic needle vibrates within a circle of bell-metal, EEE, divided into degrees and half degrees; and a line, passing through the middle of the needle to the ends, points to the divisions. The needle of this instrument was balanced, before it was made magnetic; but by means of a cross, the ends of which are FFFF, (contrived by the reverend Mr Mitchell) fixed on the axis of the needle, on the arms of which are cut very fine ferrets to receive small buttons, that may be screwed nearer or farther from the axis, the needle may be adjusted both ways to a great nicety, after being made magnetic, by reversing the poles, and changing the sides of the needle. GG are two levels, by which the line of 0 degrees of the instrument.

Needle.

strument is set horizontal, by means of the four adjusting screws LLLL; H is the perpendicular axis, by which the instrument may be turned, that the divided face of the circle may front the east or west; to this axis is fixed an index I, which points to an opposite line on the horizontal plate K when the instrument is turned half round; MMMM are screws which hold the glass-cover to keep the needle from being disturbed by the wind. When this needle is constructed for sea, it is suspended by an universal joint on a triangular stand, and adjusted vertically by a plumb-line and button above the divided circle and the dovetail work at the upper 90; and the divisions on the circle are adjusted so as to be perpendicular to the horizon by the same plumb-line, and an adjoining screw; and when it is adjusted, a pointer annexed to a screw, which serves to move the divided circle, is fixed at the lowest 0. Whenever the instrument is used to find the dip, it must be so placed that the needle may vibrate exactly in the magnetic meridian.

*Magnetical NEEDLE*, in navigation, a needle touched with a loadstone, and sustained on a pivot or centre; on which playing at liberty, it directs itself to certain points in or under the horizon; whence the magnetical needle is of two kinds, viz. horizontal and inclinatory. See the article *MAGNET*.

Horizontal needles are those equally balanced on each side the pivot that sustains them; and which, playing horizontally with their two extremes, point out the north and south points of the horizon. For their application and use, see the article *COMPASS*.

In the construction of the horizontal needle, a piece of pure steel is provided; of a length not exceeding six inches, lest its weight should impede its volubility; very thin, to take its verticity the better; and not pierced with any holes, or the like, for ornament sake, which prevent the equable diffusion of the magnetic virtue. A perforation is then made in the middle of its length, and a brass-cap or head soldered on, whose inner cavity is conical, so as to play freely on a style or pivot headed with a fine steel point. The north point of the needle in our hemisphere is made a little lighter than the southern; the touch always destroying the balance, if well adjusted before, and rendering the north end heavier than the south, and thus occasioning the needle to dip.

The method of giving the needle its verticity or directive faculty, has been shewn already under the article *MAGNET*; but if, after touching, the needle be out of its equilibrium, something must be filed off from the heavier side, till it balance evenly.

Needles in sea-compasses are usually made of a rhomboidal or oblong form: we have given their structure already under the article *COMPASS*.

The needle is not found to point precisely to the north, except in very few places; but deviates from it more or less in different places, and that too at different times; which deviation is called its *declination* or *variation from the meridian*. See the article *VARIATION*.

*NEEDLE-Fish*. See *SYNGNATHUS*.

*NEEDLES*, in geography, two capes or headlands at the west end of the Isle of Wight, which it is very difficult to pass on account of the sands and rocks.

*NEFASTI DIES*, in Roman antiquity, an appellation given to those days wherein it was not allowed to administer justice, usually marked in the calendar by N. or N. P. i. e. *nefastus prima*.

*NEGAPATAN*, a town of Asia, in the peninsula on this side the Ganges, and on the coast of Coromandel. It was first a colony of the Portuguese, but was taken from them by the Dutch. The factory purchase very little besides tobacco and long linen cloths; however, the Dutch have thought proper to erect a fort here. It is situated in E. Long. 79. 10. N. Lat. 11. 15.

*NEGATION*, in logic, an act of the mind affirming one thing to be different from another; as that the soul is not matter. See *LOGIC*.

*NEGATIVE*, in general, something that implies a negation: thus we say, negative quantities, negative powers, negative signs, &c.

*NEGATIVE Electricity*. See the article *ELECTRICITY passim*. See also *POSITIVE Electricity*.

*NEGOMBO*, a sea-port town of Asia, on the west coast of Ceylon. It has a fort built by the Portuguese, which was taken from them by the Dutch in 1640. E. Long. 80. 25. N. Lat. 17. 0.

*NEGRIL POINT*, the most westerly promontory of the island of Jamaica.

*NEGROES*, properly the inhabitants of Nigritia or Negroland in Africa, called also *Blacks*; and *Moor*s; but this name is now given to all the *Blacks*.

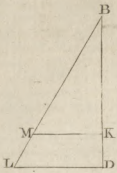
The origin of the Negroes, and the cause of this remarkable difference from the rest of the human species, has much perplexed the naturalists. Mr Boyle has observed, that it cannot be produced by the heat of the climate: for though the heat of the sun may darken the colour of the skin, yet experience does not show that it is sufficient to produce a new blackness like that of the Negroes.

In Africa itself, many nations of Ethiopia are not black; nor were there any blacks originally in the West Indies. In many parts of Asia, under the same parallel with the African region inhabited by the blacks, the people are but tawny. He adds, that there are Negroes in Africa beyond the southern tropic; and that a river sometimes parts nations, one of which is black, and the other only tawny. Dr Barreir alleges, that the galls of Negroes is black, and being mixed with their blood is deposited between the skin and scarf-skin. However, Dr Mitchell of Virginia, in the Philosophical Transactions n<sup>o</sup> 476, has endeavoured by many learned arguments to prove, that the influence of the sun in hot countries, and the manner of life of their inhabitants, are the remote causes of the colour of the Negroes, Indians, &c. See *AMERICA*, n<sup>o</sup> 48—51. and *COLOUR of the Human Species*.

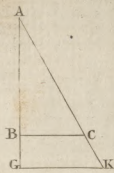
Negroes are brought from Guinea, and other coasts of Africa, and sent to the colonies in America, to cultivate tobacco, sugar, indigo, &c. and in Mexico and Peru to dig in the mines; and this commerce, however in defensible on the foot of religion or humanity, is now carried on by all the nations that have settlements in the West Indies. Those Negroes make the best slaves who are brought from Angola, Senegal, Cape Verd, the river Gambia, the kingdoms of Joloffes, &c. There are various ways of procuring them: some, to avoid famine, sell themselves, their

*Nefasti  
&  
Negroes.*

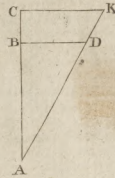
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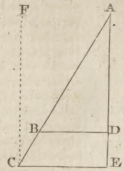
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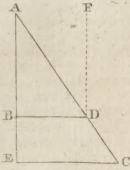
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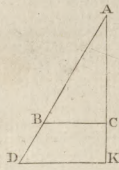
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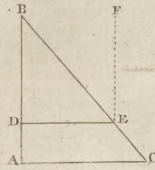
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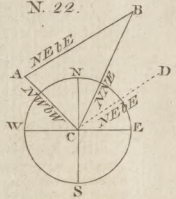
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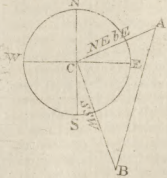
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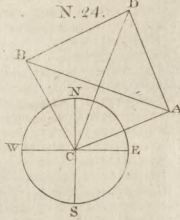
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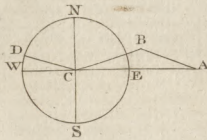
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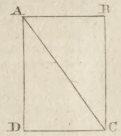
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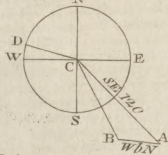
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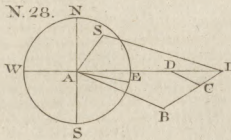
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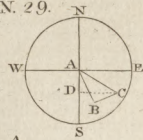
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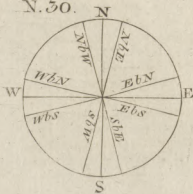
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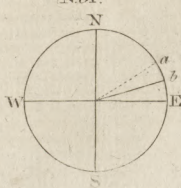
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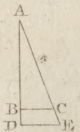
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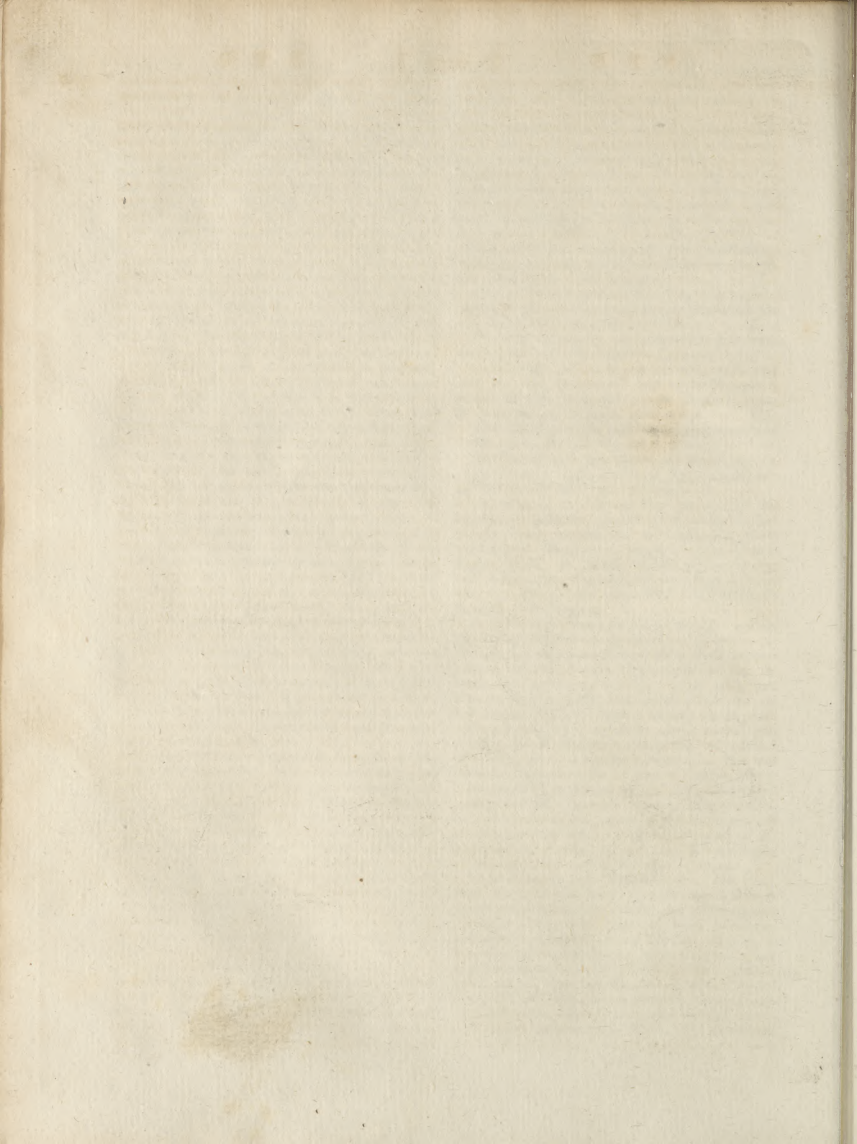


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Negroland. their wives and children, to their princes or other great men; others are made prisoners of war; and great numbers are seized in excursions made for that very purpose by the petty princes into one another's territories, in which it is usual to sweep away all, without distinction of age or sex.

**NEGROLAND, or NIGRITIA,** a country of Africa, lying next to Guinea towards the north, and extending from 18° of west to 150° of east longitude, and from 10° to 20° of north latitude. On the north it is bounded by Zaara or the Desert; on the east, by countries unknown; on the south, by Guinea; and on the west, by the Atlantic Ocean; and is watered by the great river Niger or Senegal, which runs through it from east to west. The Europeans have settlements on the coasts of this country, especially near the mouths of the Niger and Gambia, which last is supposed to be a branch of the former. A great many nations inhabit the banks of the rivers; some Pagans, some Mohammedans, of different languages, and independent of one another. The country is fruitful, especially along the rivers; abounding in rice, Guinea grain, and Indian corn, where it is cultivated; and with cocoa-nuts, plantains, pulse, palm-trees, and tropical fruits; nor is it destitute of cattle, and a variety of other animals, particularly such as abound in Guinea.

Negroland is fertilized by the overflowing of its rivers the Senegal and Gambia, as Egypt is by the Nile. It hath not yet been ascertained whether the Gambia is a branch of the Senegal or not. As far as the Europeans have penetrated up the country, they appear to be distinct; and the Munding Negroes report that the Gambia has a different origin. The entrance into the Niger or Senegal river is narrow and somewhat difficult, by reason of its immovable bar and sandy shoals, as well as the several islands at the mouth of it, and the several canals and marshes that clog it: but after sailing up eight or ten leagues, it is found broad and deep, and fit to carry large vessels; and, excepting about five or six leagues on each side above the mouth, which is sandy and barren ground, the banks are covered with stately trees and villages, and the country in general is fertile and well watered; for, like the Nile, this river overflows its banks for many leagues, and enriches the land to a great degree, though, for want of skill, the inhabitants do not reap the advantages which they might obtain from its fertility. The people on both sides of the river live as near to it as they can, and feed great herds of cattle, sowing large and small millet, the former of which is called by us *Turkey wheat*, in great quantities, and with great increase. If the river fails of overflowing at its usual season, a great scarcity, if not a downright famine, never fails to ensue in the adjacent country; and, even when it overflows regularly, it breeds such vast flights of grasshoppers and insects, as quite darken the air, and frequently eat up all the product of the earth: in which case the only remedy the people have is to kill those insects and eat them; which they do either by pounding in leathern bags, and then boiling them in milk, or, which is reckoned the more delicious method, by frying or broiling them over a light blaze, in a frying-pan full of holes. Thus the legs and wings of the insects are burnt off, and the

rest of the body is sufficiently roasted to be eaten as a dainty, which they look upon to be very wholesome and nourishing.

To the east, north-east, and south-east of the island of Senegal, the country, as far as it is known, is over-run with woods and marshes; the Senegal, Gambia, and Sherbro, which are looked upon by some as branches of one immense river, passing through it in their way to the Atlantic Ocean. During the rainy months, which begin in July, and continue to October, they lay the whole country under water; and indeed the sudden rise of these rivers is incredible to such as are not acquainted with the violent rains that fall between the tropics. At Galam, 900 miles from the mouth of the Senegal, the waters rise 150 feet perpendicular from the bed of the river. At the island of Senegal, the river rises gradually, during the rainy season, above 20 feet perpendicular over part of that flat coast; which of itself so freshens the water, that ships lying at anchor, at the distance of three leagues from its mouth, generally make use of it, and fill their water there for their voyage home. When the rains are at an end, which usually happens in October, the intense heat of the sun soon dries up those stagnating waters which lie on the higher parts, and the remainder from lakes and marshes, in which are found all sorts of dead animals. At last, those too are quite dried up; and then the effluvia that arise are almost quite insupportable. At this season the winds blow so hot from the land, that they may be compared to the heat proceeding from the mouth of an oven, and they bring with them an intolerable smell. The wolves, tigers, lions, and other wild beasts, then resort to the river, keeping their body under water, and only their snout above it for the sake of breathing. The birds soar to an immense height in the air, and fly a vast way over the sea, where they continue till the wind changes, and comes from the west. See **SENEGAL, GUINEA, GOLD-Coast, and SLAVE-Coast.**

**NEGROMANCY.** See **NECROMANCY.**

**NEGROPONT,** anciently *Eubœa*, an island of the Archipelago, stretching along the eastern coast of Achaia or Livadia, from which it is separated by a narrow channel called the *Eurippus*. This strait is so narrow, that the island is joined to the continent by a bridge thrown over it; and, here it is thought, there was formerly an isthmus. The irregularity of the tides in the Eurippus hath from the remotest antiquity been very remarkable, and this irregularity is found to be connected with the age of the moon. From the three last days of the old moon to the eighth day of the new moon, and from the 14th to the 20th day inclusive, they are regular; but on the other days they are irregular, flowing 12, 13, or 14 times in the space of 24 hours, and ebbing as often. The island is 90 miles long and 25 broad in the widest part; and produces corn, oil, fruit, and cattle, in great abundance. The only place in the island worth notice is the capital, which is also called *Negropont*; and which is walled, and contains about 15,000 inhabitants; but the Christians are said to be much more numerous than the Turks. The captain-bathaw, or admiral of Turkey, who is also governor of the city, the island, and the adjacent continent of Greece, resides here; and the harbour, which is very safe and spacious, is seldom

Nehemiah without a fleet of galleys, ready to be put to sea against the pirates and the Maltese. A part of the bridge between the city and the coast of Greece, consists of a drawbridge no longer than just to let a galley pass through.

||  
Nelson.

NEHEMIAH, a canonical book of the Old Testament, so called from the name of its author. Nehemiah was born in Babylon during the captivity, and succeeded Ezra in the government of Judah and Jerusalem. He was a Jew, and was promoted to the office of cup-bearer to Artaxerxes Longimanus king of Persia; when the opportunities he had of being daily in the king's presence, together with the favour of Esther the queen, procured him the favour of being authorized to repair and fortify the city of Jerusalem in the same manner as it was before its destruction by the Babylonians. On his going to Jerusalem, he finished the rebuilding of the walls in 52 days, and dedicated the gates of the city with great solemnity. He then reformed some abuses which had crept in among his countrymen, particularly the extortion of the usurers, by which the poor were so oppressed as to be forced to sell their lands and children for support; after which he returned to Persia, and came back again with a new commission, by virtue of which he regulated every thing relating both to the state and religion of the Jews. The history of these transactions is the subject of this book.

NEISSE, a handsome town of Silesia in Germany, and the residence of the bishop of Breslaw, who has a magnificent palace here. The air is very wholesome, and provisions are cheap; the inhabitants carry on a great trade in wine and linen. This place suffered greatly by an inundation and fire in 1729. It was taken by the Prussians in 1741, who augmented the fortifications after the peace in 1742, and built a citadel to which they gave the name of *Prussia*. It is seated on a river of the same name; in E. long. 17. 35. N. lat. 50. 32.

NELSON (Robert), a learned and pious English gentleman, was the son of Mr John Nelson a considerable Turkey merchant, and was born in June 1656. He had the first part of his education at St Paul's school, London; but the principal part was under a private tutor in his mother's house, after which he studied at Trinity College, Cambridge. In 1680 he was chosen a fellow of the Royal Society; being probably inclined to receive that honour out of respect to his friend and school-fellow Dr Edmund Halley, for whom he had a particular regard, and in whose company he set out on his travels abroad the December following. In the road to Paris, they saw the remarkable comet which gave rise to the cometical astronomy by Sir Isaac Newton; and our author, apparently by the advantage of his fellow-traveller's instructions, sent a description of it to Dr, afterwards archbishop, Tillotson, by whom he was very much esteemed. From Paris he went with his fellow-traveller to Rome, where he fell into the acquaintance of Lady Theophila Lucy, widow of Sir Kingfmill Lucy of Broxburne in Hertfordshire, bart. and second daughter of George earl of Berkeley, who soon discovered a strong passion for him: this concluded in marriage, after his arrival in England in 1682. But it was some time before she confessed to Mr Nelson the change

of her religion; which was owing to her conversations at Rome with cardinal Philip Howard, who was grandson of the earl of Arundel, the collector of the Arundelian marbles, &c. and had been raised to the purple by pope Clement X. in May 1675. Nor was this important alteration of her religious sentiments confined to her own mind, but involved in it her daughter by her first husband, whom she drew over to her new religion; and her zeal for it prompted her even to engage in the public controversy then depending. She is the supposed authoress of a piece written in 1686, 4to, under the title of, "A discourse concerning a judge of controversy in matters of religion, shewing the necessity of such a judge."

This misfortune touched her husband very nearly. He employed not only his own pen, but those of his friends Dr Tillotson and Dr Hickee, to recover her; but all proved ineffectual; and she continued in the communion of the church of Rome till her death. She was a person of fine sense and understanding. Dr Tillotson particularly laments her case on that account; and even seems not to be entirely free from all apprehensions of the influence she might have upon her husband in this important affair. But Mr Nelson's religion was too much the result of his learning and reason to be shaken by his love, which was equally steady and inviolable. Her change of religion made no change in his affections for her; and when she relapsed into such a bad state of health as obliged her to go and drink the waters at Aix, he attended her thither in 1688: and not liking the prospect of the public affairs at home, he proceeded to make a second trip to Italy, taking his lady, together with her son and daughter by her former husband, along with him. He returned through Germany to the Hague, where he staid some time with lord Dursley, who was married to his wife's sister.

From the Hague he arrived in England, in the latter end of 1691; where, being averse to the Revolution, he declared himself a nonjuror, and left the communion of the church of England. In this last point he had consulted Dr Tillotson, and followed his opinion, who thought it no better than a trick, detestable in any thing, and especially in religion, to join in prayers where there was any petition which was held to be sinful. Thus, notwithstanding their difference of opinion in this case, the friendship between them remained the same; and the good archbishop expired in his friend's arms in 1694.

Our author's new character unavoidably threw him into some new connections. Among these we find mentioned particularly Mr Kettlewell, who had resigned his living at Colehill in Warwickshire on account of the new oaths, and afterwards resided in London. This pious and learned divine also agreed with him in leaving the communion of the established church; yet at the same time persuaded him to engage in the general service of piety and devotion; obliging to him, that he was very able to compose excellent books of that kind, which would be apt to do more good as coming from a layman. This address corresponded with the truly catholic spirit of our author; who accordingly published many works of piety, which are deservedly esteemed.

At the same time, he engaged zealously in every public

Nelson.

**Nemausus** public scheme for the honour and interest, as well as for propagating the faith, and promoting the practice of true Christianity, both at home and abroad; several proposals for building, repairing, and endowing churches, and charity-schools particularly.

Upon the death of Dr William Lloyd, the deprived bishop of Norwich, in the end of the year 1709, he returned to the communion of the church of England. Dr Lloyd was the last surviving of the deprived bishops by the Revolution, except Dr Kenn, by whose advice Mr Nelson was determined in this point. Mr Nelson's tutor, Dr George Bull, bishop of St David's, dying before the expiration of this year, he was easily prevailed upon by that prelate's son, to draw up an account of his father's life and writings, as he had maintained a long and intimate friendship with his Lordship, which gave him an opportunity of being acquainted with his solid and substantial worth. The life was published in 1713; and, as our author had long before laboured under a constitutional weakness, which had brought on an asthma and dropsy in the breast, the distemper grew to such a height soon after the publication of that work, that, for the benefit of the air, he retired at length to Kennington, where he expired on the 16th of January 1714-15. He left his whole estate to pious and charitable uses; particularly to charity-schools.

**NEMAUSUS**, or **NEMAUSUM**, (anc. geog.) the capital of the *Arcemici* in *Gallia Narbonensis*; a colony, (Coin), with the surname *Augusta*, (Inscription). In it stands a Roman amphitheatre, which is still almost entire. Now *Nisnes* in Languedoc.

**NEMEA**, (Strabo, *Livy*); a river of Achaia, running between Sicyon and Corinth, the common boundary of both territories, and falling into the Corinthian bay.

**NEMFA**, (anc. geog.), situated between Cleonæ and Philus in Argolis; whether town, district, or other thing, uncertain: there a grove stood in which the Argives celebrated the Nemean games, and there happened all the fabulous circumstances of the Nemean lion. The district Nemea is called *Bembinadia*, (Pliny); a village, *Bemlina*, standing near Nemea, (Strabo). Stephanus places Nemea in Elis; though not in, but on, the borders of Elis; Pliny, erroneously, in Arcadia. In the adjoining mountain is still shewn the den of the lion, distant 15 stadia from the place *Nemea*, (Pausanias); in which stands a considerable temple of Jupiter Nemæus and Cleonæus, from the vicinity of these two places. This place gave name to the Nemean games, celebrated every third year.

**NEMEAN GAMES**, so called from Nemea, a village between the cities of Cleonæ and Philus, where they were celebrated every third year. The exercises were chariot-races, and all the parts of the Pentathlon. These games were instituted in memory of Opheltes or Archemorus, the son of Euphetes and Creusa, and who was nursed by Hyppolete; who leaving him in a meadow while she went to strew the besiegers of Thebes a fountain, at her return found him dead, and a serpent twined about his neck: whence the fountain, before called *Langia*, was named *Archemorus*; and the captives, to comfort Hyppolyte, instituted these games. Others ascribe their institution to Hercules, after his victory over the Nemean lion. Others allow, that

they were instituted first in honour of Archemorus; but intermitted, and revived again by Hercules. The victors were crowned with parsley, an herb used at funerals, and feigned to have sprung from Archemorus's blood.

**NEMESIANUS** (Aurelius Olympius), a Latin poet, born at Carthage, who wrote a poem on the chase, intitled *Cyngeticon*, and four eclogues, which are still extant. This poet lived under the reign of Carus and his sons Carinus and Numerianus, about the year 281. People were so fond of his poem in the eighth and ninth centuries, that young men were obliged to read it in the public schools.

**NEMESIS**, in Pagan worship, the daughter of Jupiter and Necessity, or, according to others, of Oceanus and Nox, had the care of revenging the crimes which human justice left unpunished. She was also called *Adrastea*, because Adrastus king of Argos first raised an altar to her; and *Rhamnusia*, from her having a magnificent temple at Rhamnus in Attica. She had likewise a temple at Rome in the Capitol. She is represented with a stern countenance, holding a whip in one hand, and a pair of scales in the other.

**NEMINE CONTRADICENTE**, "none contradicting it;" a term chiefly used in parliament when any thing is carried without opposition.

**NEMOURS**, a town of the Isle of France in the Gatinois, with the title of a duchy. It is seated on the river Loing, in E. long. 2. 45. N. lat. 48. 15.

**NENIA**, or **NÆNIA**, in the ancient poetry, a kind of funeral song sung to the music of flutes at the obsequies of the dead. Authors represent them as forty compositions, sung by hired women-mourners called *Præficee*. The first rise of these *Nenia* is ascribed to the physicians. In the heathen antiquity the goddess of tears and funerals was called *Nenia*; whom some suppose to have given that name to the funeral song, and others to have taken her name from it.

**NEOMAGUS**, (Ptolemy); **NOVIOMAGUS**, (Antonine); a town of the Regni in Britain: now thought to be Guildford in Surrey, (Lhuyd); or Croydon, (Talbot). But Camden takes it to be Woodcote, two miles to the south of Croydon; where traces of an ancient town are still to be seen.

**NEOMAGUS**, (Ptolemy); **NOVIOMAGUS**, (Antonine); a town of the Triviri on the Moselle. Now *Nunagen*, 14 miles east, below Triers.

**NEOMAGUS**, (Ptolemy); **NOVIOMAGUS** *Lexoviorum*, (Antonine); a town of Gallia Celtica. Now *Lisieux*, in Normandy.

**NEOMAGUS**, (Ptolemy); **NOVIOMAGUS** *Nemetum*, (Antonine). Now *Spires*, a city of the Palatinate, on the left or west side of the Rhine.

**NEOMAGUS**, (Ptolemy); a town of Gallia Narbonensis, on the confines of the *Tricastini*. Now *Nyon* in Dauphiné.

**NEOMENIA**, or **NOUMENIA**, a festival of the ancient Greeks, at the beginning of every lunar month, which, as the name imports, was observed upon the day of the new moon, in honour of all the gods, but especially Apollo, who was called *Neomenios*, because the sun is the fountain of light, and whatever distinction of times and seasons may be taken from other planets, yet they are all owing to him as the original of those borrowed rays by which they shine.

Neophytes

The games and public entertainments at these festivals were made by the rich, to whose tables the poor flocked in great numbers. The Athenians at these times offered solemn prayers and sacrifices for the prosperity of their country during the ensuing month. See GAMES.

The Jews had also their neomenia, or feast of the new moon, on which peculiar sacrifices were appointed; and on this day they had a sort of family entertainment and rejoicing. The most celebrated neomenia of all others was that at the beginning of the civil year, or first day of the month Tifri, on which no servile labour was performed: they then offered particular burnt-sacrifices, and founded the trumpets of the temple. The modern Jews keep the neomenia only as a feast of devotion, which any one may observe or not as he pleases.

NEOPHYTES, "new plants;" a name given by the ancient Christians, to those heathens who had newly embraced the faith; such persons being considered as regenerated, or born anew by baptism. The term *neophytes* has been also used for new priests, or those just admitted into orders, and sometimes for the novices in monasteries. It is still applied to the converts made by the missionaries among the infidels.

NEPÀ, in zoology, a genus of insects belonging to the order of hemiptera. The rostrum is inflected; the antennæ are shorter than the thorax; and the hind-feet are hairy and fitted for swimming. There are seven species.

NEPER, or NAPIER (John), baron of Merchilton in Scotland, whose high attainments in many branches of useful literature render his memory valuable, was born in 1550. He had a peculiar turn to mathematical investigations and useful inventions: among the latter may be ranked that instrument called *Neper's Rods or Bones*, to facilitate the multiplication and division of large numbers; and his invention of logarithms have spread his fame throughout the world. This discovery was contained in his *Canon mirabilis Logarithmorum*, dedicated to prince Charles, and published in 1614. In his *Rabdologia*, published in 1616, he mentions another species of those numbers; when, finding his health declining, he engaged Mr Briggs to prosecute that useful laborious scheme. Besides his abilities in these calculations, he is said to have wrote an *Exposition on the Revelation*: an undertaking in which his rare talents in reason and computation could however afford him no advantages; nor is he remembered by it. He died in 1622.

NEPER'S Rods, or *Bones*, an instrument invented by J. Neper, baron of Merchilton in Scotland, whereby the multiplication and division of large numbers is much facilitated.

As to the construction of NEPER'S Rod: Suppose the common table of multiplication to be made upon a plate of metal, ivory, or pasteboard, and then conceive the several columns (standing downwards from the digits on the head) to be cut asunder; and these are what we call *Neper's rods for multiplication*. But then there must be a good number of each; for as many times as any figure is in the multiplicand, so many rods of that species (i. e. with that figure on the top of it) must we have; though six rods of each species will be sufficient for any example in common af-

fairs: there must be also as many rods of 0's.

But before we explain the way of using these rods, there is another thing to be known, viz. that the figures on every rod are written in an order different from that in the table. Thus the little square space or division in which the several products of every column are written, is divided into two parts by a line across from the upper angle on the right to the lower on the left; and if the product is a digit, it is set in the lower division; if it has two places, the first is set in the lower, and the second in the upper division; but the spaces on the top are not divided: also there is a rod of digits, not divided, which is called the *index rod*, and of this we need but one single rod. See the figure of all the different rods, and the index, separate from one another, in Plate CCI. fig. 1.

*Multiplication by NEPER'S Rods.* First lay down the index-rod; then on the right of it set a rod, whose top is the figure in the highest place of the multiplicand; next to this again, set the rod, whose top is the next figure of the multiplicand; and so on in order, to the first figure. Then is your multiplicand tabulated for all the nine digits; for in the same line of squares standing against every figure of the index rod, you have the product of that figure; and therefore you have no more to do but to transfer the products and sum them. But in taking out these products from the rods, the order in which the figures stand obliges you to a very easy and small addition: thus, begin to take out the figure in the lower part, or unit's place, of the square of the first rod on the right; add the figure in the upper part of this rod to that in the lower part of the next, and so on; which may be done as fast as you can look on them. To make this practice as clear as possible, take the following example.

Example: To multiply 4768 by 385. Having set the rods together for the number 4768 (*ibid.* n.º 2.) against 5 in the index, I find this number, by adding according to the rule,

23840
38144
14304

Total product 1835680

To make the use of the rods yet more regular and easy, they are kept in a flat square box, whose breadth is that of ten rods, and the length that of one rod, as thick as to hold six (or as many as you please) the capacity of the box being divided into ten cells, for the different species of rods. When the rods are put up in the box (each species in its own cell distinguished by the first figure of the rod set before it on the face of the box near the top) as much of every rod stands without the box as shews the first figure of that rod: also upon one of the flat sides without and near the edge, upon the left hand, the index rod is fixed; and along the foot there is a small ledge; so that the rods when applied are laid upon this side, and supported by the ledge, which makes the practice very easy; but in case the multiplicand should have more than nine places, that upper face of the box may be made broader. Some make the rods with four different faces, and figures on each for different purposes.

*Division by NEPER'S Rods.* First tabulate your divisor; then you have it multiplied by all the digits, out of which you may choose such convenient divisors as will

Neper.



Nepet.  
Nepeta.

will be next lefts to the figures in the dividend, and write the index answering in the quotient, and so continually till the work is done. Thus 2179788, divided by 6123, gives in the quotient 356.

Having tabulated the divisor 6123, you see that 6123 cannot be had in 2179; therefore take five places, and on the rods find a number that is equal or next less to 21797, which is 18369; that is, 3 times the divisor: wherefore set 3 in the quotient, and subtract 18369 from the figures above, and there will remain 3428; to which add 8, the next figure of the dividend, and seek again on the rods for it, or the next less, which you will find to be five times; therefore set 5 in the quotient, and subtract 30615 from 34288, and there will remain 3673; to which add 8, the last figure in the dividend, and finding it to be just 6 times the divisor, set 6 in the quotient.

6123)2179788(356

18369

34288

30615

36738

36738

00000

**NEPETA, CATMINT, or Nep;** a genus of the gymnospermia order, belonging to the didynamia class of plants. There are 14 species; the most remarkable is the cataria, common nep, or catmint. This is a native of many parts of Britain, growing about hedges and in waste places. The stalk is a yard high, and branched; the leaves are hoary; the flowers flesh-coloured, growing verticillate in spikes at the tops of the branches: the middle segment of the lower lip is spotted with red. The plant has a bitter taste, and strong smell, not unlike pennyroyal. An infusion of this plant is reckoned a good cephalic and emmenagogue; being found very efficacious in chlorotic cafes. Two ounces of the expressed juice may be given for a dose. It is called *catmint*, because cats are very fond of it, especially when it is withered; for then they will roll themselves on it, and tear it to pieces, chewing it in their mouths with great pleasure. Mr Ray mentions his having transplanted some of the plants of this sort from the fields into his garden, which were soon destroyed by the cats; but the plants which came up from seeds in his garden escaped: this verifies an old proverb, *viz.* "If you set it, the cats will eat it; if you sow it, the cats will not know it." Mr Withering is of opinion, that where there is a quantity of plants growing together, the cats will not meddle with them; but Mr Millar assures us, that he has frequently transplanted one of these plants from another part of the garden, within two feet of which, some came up from seeds; in which case the latter have remained unhurt, when the former have been torn to pieces and destroyed: he acknowledges, however, that, where there is a large quantity of the herb growing together, they will not meddle with it. This plant is very hardy, and is easily propagated by seeds. If sown upon a poor dry soil, the plants will not grow too rank, but will continue longer, and appear much handsomer, than in rich ground, where they grow too luxuriant, and

have not so strong a scent.

**NEPHEW,** a term relative to uncle and aunt, signifying a brother's or sister's son; who, according to the civil law, is in the third degree of consanguinity, but according to the canon in the second.

**NEPHRITIC,** something that relates to the kidneys. See **KIDNEY**.

**NEPHRITIC Wood, (lignum nephriticum),** a wood of a very dense and compact texture, and of a fine grain, brought to us from New Spain in small blocks, in its natural state, and covered with its bark. It is to be chosen of a pale colour, sound and firm, and such as has not lost its acrid taste; but the surest test of it is the infusing it in water: for a piece of it infused only half an hour in cold water, gives it a changeable colour, which is blue or yellow, as variously held to the light. If the vial it is in be held between the eye and the light, the tincture appears yellow; but if the eye be placed between the light and the vial, it appears blue. We often meet with this wood adulterated with others of the same pale colour; but the dusky black hue of the bark is a striking character of this.

The tree is the *caatli* of Hernandez. It grows to the height of our pear-tree, and its wood while fresh is much of the same texture and colour; the leaves are small and oblong, not exceeding half an inch in length, or a third of an inch in breadth; the flowers are small, of a pale-yellow colour, and oblong shape, standing in spikes: the cups they stand in are divided into five segments at the edge, and are covered with a reddish down. This is the best description of the tree that can be collected from what has been hitherto written of it; nobody having yet had an opportunity of taking its true characters.

This wood is a very good diuretic, and is said to be of great use with the Indians in all diseases of the kidneys and bladder, and in suppression of urine, from whatever cause. It is also recommended in fevers, and in obstructions of the viscera. The way of taking it among the Indians is only an infusion in cold water.

**NEPHRITIC Stone,** a soft, brittle, opaque stone, not susceptible of a good polish; smooth, and, as it were, unctuous to the touch; variegated with several colours, of which green is the principal. It is found in Saxony, Bohemia, Switzerland, Spain, and Mexico; and from the imaginary virtues ascribed to it in nephritic disorders, has been ranked among the precious stones, but differs exceedingly from them in all its sensible qualities. Neumann finds fault with some authors for referring this stone to the jaspers, agates, or marbles; from all of which, he says, it widely differs: it wants the red specks of the jaspers, the hardness and compactness of the others, and all of them want its unctuousity or soapiness. Out of 60 grains of nephritic stone, vinegar dissolved three; oil of vitriol seven; spirit of vitriol 14; spirit of nitre 16; aqua regia 18; and spirit of salt 20. The spirit of salt acquired a greenish-yellow tincture; aqua regia a gold yellow; oil of vitriol a dark-brownish; the other acids remained colourless. Both the marine acid and aqua regia left the undissolved earth whitish; the nitrous acid greyish; the diluted vitriolic acid brownish-yellow; the concentrated light reddish-brown; the acetous,

Nephev,  
Nephritic.

Nephritis  
||  
Neptune.

tous, unchanged. An ounce of this substance powdered, and distilled in a retort in an open fire, yielded about a drachm and an half of phlegm, which had a penetrating empyreumatic smell, but made no change in the colour of the syrup of violets. On distilling four ounces together, there was an appearance of an actual empyreumatic oil, with a saline matter, which was found to be sal ammoniac. The matter remaining in the retort was of a reddish-brown colour. An ounce of the powdered stone, mixed with an equal quantity of fixed alkaline salt, and urged with a strong fire, did not melt, but formed a quite porous mass, in colour inclining to reddish-grey, and weighing two drachms less than the mixture did at first. Dr Lewis tells us, that the nephritic stone is a species of the indurated clays, called, from their unctuousness, *steatita*. With these it agrees, not only in its obvious properties, but likewise in its burning hard, the peculiar characteristic of argillaceous earths. Its green colour seems to proceed from copper. Pott relates, that on fusion with an equal quantity of borax, it yielded a beautiful red mass resembling an agate, with a grain of copper at the bottom. The nephritic stone is considerably the hardest of all the substances of this class.

NEPHRITICS, in pharmacy, medicines proper for diseases of the kidneys, especially the stone.—Such particularly are the roots of althæa, dog's-grass, asparagus, fago, pellitory of the wall, mallows, pimpinella, red chick-pease, peach-kernels, turpentine, &c.

NEPHRITIS, or inflammation of the kidneys. See MEDICINE, n<sup>o</sup> 304.

NEPOS (Cornelius), a celebrated Latin historian, born at Hosiilia near Verona, flourished in the time of the emperor Augustus. He was the friend of Cicero and Atticus; and composed several excellent works, of which there are only extant the lives of the most illustrious Greek and Roman captains.

NEPTUNE, in Pagan worship, the god of the sea, was the son of Saturn and Velta, or Ops, and the brother of Jupiter and Pluto. He assisted Jupiter in his expeditions; on which that god, when he arrived at the supreme power, assigned him the sea and the islands for his empire. He was, however, expelled from heaven with Apollo, for conspiring against Jupiter, when they were both employed by Laomedon king of Phrygia in building the walls of Troy; but that prince dismissing Neptune without a reward, he sent a sea-monster to lay waste the country, on which he was obliged to expose his daughter Heliene. He is said to have been the first inventor of horsemanship and chariot-racing; on which account Mithridates king of Pontus threw chariots drawn by four horses into the sea in honour of this god; and the Romans instituted horse-races in the circus at his festival, during which all other horses left working, and the mules were adorned with wreaths of flowers.

In a contest with Minerva he produced a horse by striking the earth with his trident; and on another occasion, in a trial of skill with Minerva and Vulcan, produced a bull, whence that animal was sacrificed to him. His favourite wife was Amphitrite, whom he long courted in vain, till sending the dolphin to intercede for him, he met with success; on which he re-

warded the dolphin by placing him among the stars. He had also two other wives, one of whom was called *Salafia*, from the salt water; the other *Venilia*, from the ebbing and flowing of the tides. He had likewise many concubines, by whom he had a great number of children. He is represented with black hair, with a garment of an azure or sea-green, holding his trident in his hand, and seated in a large shell drawn by sea-horses, attended by the sea-gods Palemon, Glaucus, and Phorcys, and the sea goddesses Thetis, Melita, and Panopæa, and a long train of tritons and sea-nymphs.

NEREIDS, in the Pagan theology, sea-nymphs, daughters of Nereus and Doris.—The Nereids were esteemed very handsome; inasmuch that Cassiope, the wife of Cephens king of Ethiopia, having triumphed over all the beauties of the age, and daring to vie with the Nereids, they were so enraged that they sent a prodigious sea-monster into the country; and, to appease them, she was commanded by the oracle to expose her daughter Andromeda, bound to a rock, to be devoured by the monster. In ancient monuments, the Nereids are represented riding upon sea-horses; sometimes with an entire human form, and at other times with the tail of a fish.

NEREIS, in zoology, a genus of animals belonging to the order of vermes mollusca. The body is oblong, linear, and fitted for creeping; it is furnished with lateral pencilled tentacula. There are 11 species; of which the most remarkable is the *noctiluca*, being one of the causes of the luminousness of the sea. They are inhabitants of almost every sea; and illuminate the water like glow-worms, but with a brighter splendour, so as at night to make the element appear as if on fire all around. Their bodies are so minute as to elude examination by the naked eye.

NEREUS, in fabulous history, a marine deity, was the son of Oceanus and Thetis. He settled in the *Ægean Sea*, was considered as a prophet, and had the power of assuming what form he pleased. He married his sister Doris, by whom he had 50 daughters called the *Nereids*, who constantly attended on Neptune, and when he went abroad surrounded his chariot.

NERO (Domitius) emperor, son of Caius Domitius Enobarbus, and of Agrippina, who married Claudius, whom Nero succeeded, A. D. 54, aged 18. He protested he would follow the example of Augustus, and at first he did; and as they once presented him the sentence of a person condemned to death, "I wish," said he, "that I could not write." But after five years reign he fell into the most extravagant crimes that ever entered the imagination of man. He would appear upon the stage in woman's dress. He committed sodomy with the greatest debauchees, and particularly Sporus, whom he kept in quality of his wife, and caused to be dressed like a woman; which gave occasion to that pleasant saying, "That the world had been happy if his father Domitius had had such a wife." He caused his mother to be murdered, his wife to be put to death, and his master Seneca to lose his life, &c. and wished that mankind had but one head, that he might have the pleasure of cutting it off. To have the glory of rebuilding Rome, he set it on fire, laid the blame upon the Christians, and began the first persecution against them.

Nereids  
||  
Nero.

Nerva  
||  
Net.

Net  
||  
Netherlands

them. Being exhausted by his immense profusion, and become the common detestation of mankind, his armies in Gaul declared against him, and Galba revolted in Spain. This cast him into despair, and in a rage he cried out, "Have I neither friend nor enemy?" So he was forced to turn his own executioner, A. D. 68, in the 32d year of his age and 14th of his reign.

NERVA (Cocceius), emperor after Domitian. He recalled those who had been banished for their religion, and forgot nothing that might contribute to the restoring of the empire to its former lustre; but finding his age would not suffer him to finish it, he adopted Trajan, and died A. C. 98.

NERVES, in anatomy; certain white glistening cords, proceeding from the brain and spinal marrow, and dividing into very small branches, which are sent off throughout all parts of the body; and which are found to be the organs of sensation and motion. See ANATOMY, n° 400.

NERVOUS FLUID. See ANATOMY, n° 400, l. NEST. See NIDUS.

Eatable Birds-Nests. See BIRDS-Nests.

NESTOR, in fabulous history, king of Pylos, and the son of Neleus and Chloris. He subdued the Eleans, and conquered the Centaurs, who would have carried off Hippodamia. He afterwards went to the siege of Troy with Agamemnon, who had a particular esteem for him on account of his wisdom and eloquence. He was then, according to Homer, so old, that he had seen three generations of men.

NESTORIANS, a Christian sect, the followers of Nestorius bishop and patriarch of Constantinople; who, about the year 520, taught that there were two persons in Jesus Christ, the divine and the human, which are united not hypostatically or substantially, but in a mylical manner; whence he concluded, that Mary was the mother of Christ, and not the mother of God. For this opinion Nestorius was condemned and deposed by the council of Ephesus; and the decree of this council was confirmed by the emperor Theodosius, who banished the bishop to a monastery.

NET, a device for catching fish and fowl. See the article FISHERY.

The taking fowls by nets is the readiest and most advantageous of all others, where numbers are to be taken. The making the nets is very easy, and what every true sportsman ought to be able to do for himself. All the necessary tools are wooden needles, of which there should be several of different sizes, some round and others flat; a pair of round-pointed and flat scissars; and a wheel to wind off the thread. The packthread is to be of different strength and thickness, according to the sort of birds to be taken; and the general size of the meshes, if not for very small birds, is two inches from point to point. The nets should neither be made too deep nor too long, for they are then difficult to manage; and they must be verged on each side with twisted thread. The natural colour of the thread is too bright and pale, and is therefore in many cases to be altered. The most usual colour is the russet; which is to be obtained by plunging the net, after it is made, into a tanner's pit, and letting it lie there till it be sufficiently tinged: this is of a double service to the net, since it preserves the thread

as well as alters the colour. The green colour is given by chopping some green wheat and boiling it in water, and then soaking the net in this green tincture. The yellow colour is given in the same manner with the decoction ofcelandine; which gives a pale straw-colour, which is the colour of stubble in the harvest-time. The brown nets are to be used on ploughed lands, the green on grass-grounds, and the yellow on stubble-lands.

NET, *Neat*, in commerce, something pure, and unadulterated with any foreign mixture.

Thus, wine is said to be *net* when not falsified or balderdash'd; and coffee, rice, pepper, &c. are *net* when the filth and ordures are separated from them. See NEAT.

A diamond is said to be *net* when it has no stains or flaws; a crystal, when transparent throughout.

NET is also used for what remains after the tare has been taken out of the weight of any merchandize; i. e. when it is weighed clear of all package. See TARE.

Thus we say, a barrel of cochineal weighs 450 pounds; the tare is 50 pounds, and there remains *net* 400 pounds.

NET Produce, a term used to express what any commodity has yielded, all tare and charges deducted.

The merchants sometimes use the Italian words *netto proceduto*, for net produce.

NETHERLANDS, anciently called *Belgia*, but since denominated *Low Countries* or *Netherlands*, from their low situation, are situated between 2° and 7° of east longitude, and between 50° and 53° 30' of north latitude: and are bounded by the German sea on the north, Germany on the east, by Lorrain and France on the south, and by another part of France and the British seas on the west; extending near 300 miles in length from north to south, and 200 miles in breadth from east to west. They consist of 17 provinces; 10 of which are called the *Austrian* and *French Netherlands*, and the other seven the *United Provinces*.

The *Austrian Netherlands* consist of the greatest part of the duchies of Brabant, Limburg, and Luxemburg, with a part of that of Gueldres; and of the counties of Flanders, Henne-gau, and Namur. The Netherlands formerly made a part of the circle of Burgundy, the whole of which once belonged to the house of Austria, and on the death of Charles V. devolved to the Burgundian Spanish line of that house; but was all afterwards lost, except the abovementioned countries, which, on the death of Charles I. king of Spain, fell to the German line of the Austrian family. These Austrian Netherlands are still considered as a circle of the empire, of which the archducal house, as being sovereign of the whole, is the sole director and summoning prince. This circle contributes its share to the imposts of the empire, and sends an envoy to the diet; but is not subject to the judicatories of the empire. It is wholly Catholic, and under a governor-general appointed by the court of Vienna.

The *French Netherlands* consist of a part of the duchy of Luxemburg, of the province of Hainault, of the earldom of Flanders, the bishopric of Liege, the Cambresis, and the county of Namur; and this government, the greatest part of which belongs to the parliament of Douay, comprehends French Flanders, the

Netfcher  
||  
Newburg

the Cambresis, French Hainault, and the French part of the earldom of Namur.—French Flanders abounds in grain, vegetables, flax, and cattle, but is in want of wood.

For the *Dutch Netherlands*, see UNITED PROVINCES.

NETSCHER (Gaspard), an eminent painter, born at Prague in Bohemia in 1639. His father dying while he was an engineer in the Polish service, his mother was obliged, on account of her religion, suddenly to leave Prague with her three sons. When she had proceeded three leagues, she stopped at a castle; which being soon after besieged, two of her sons were slaved to death; but she herself found means to escape out of the fortrefs by night, and to save her only remaining child. Carrying him in her arms, she reached Arnheim in Guelderland, where she found means to support herself, and breed up her son. At length a doctor of physic took young Netfcher into his patronage, with the view of giving him an education proper for a physician: but Netfcher's genius leading him to painting, he could not forbear scrawling out designs upon the paper on which he wrote his themes; and it being found impossible to conquer his fondness for drawing, he was sent to a glazier, who was the only person in the town that understood drawing. Netfcher soon finding himself above receiving any farther assistance from his master, was sent to Deventer, to a painter named *Terburg*, who was an able artist and burgomaster of the town; and having acquired under him a great command of his pencil, went to Holland, where he worked a long time for the dealers in pictures, who paid him very little for his pieces, which they sold at a high price. Disgusted at this ungenerous treatment, he resolved to go to Rome, and for that purpose embarked on board a vessel bound for Bourdeaux. But his marrying in that city prevented his travelling into Italy: and therefore, returning into Holland, he settled at the Hague; where observing that portrait-painting was the most profitable, he applied himself solely to it, and acquired such reputation, that there is not a considerable family in Holland that has not some of his portraits; and besides, the greatest part of the foreign ministers could not think of quitting Holland without carrying with them one of Netfcher's portraits, whence they are to be seen all over Europe. He died at the Hague, in 1684; leaving two sons, Theodore and Constantine Netfcher, both of them good portrait-painters.

NETTINGS, in a ship, a sort of grates made of small ropes seized together with rope-yarn or twine, and fixed on the quarters and in the tops; they are sometimes stretched upon the ledges from the waster-trees to the roof-trees, from the top of the forecastle to the poop, and sometimes are laid in the wake of a ship to serve instead of gratings.

NETTLE, in botany. See URTICA.

Sea-NETTLE. See MEDUSA, and ANIMAL-Flower.

NETTLE-Tree. See CELTIS.

NETTUNO, a handsome town of Italy, in the Campagna of Rome. It is but thinly peopled, though seated in a fertile soil. The inhabitants are almost all hunters. E. Long. 12. 57. N. Lat. 41. 30.

NEWBURG, the name of several towns of Germany, two of which are the chief towns of duchies of the same name; one in Bavaria, and the other in the

Palatinate.

NEVERS, a considerable town of France, and capital of Nivernois, in Orleanois, with the title of a duchy, an ancient castle, and a bishop's see. It is built in the form of an amphitheatre, and contains several fine buildings. It is seated on the river Loir, over which there is an handsome bridge, and at the end of it a fine large causeway reaching to the town. E. Long. 3. 14. N. Lat. 46. 59.

NEUFCHATEAU, a town of France, in Lorraine, and capital of the chatellenie of Chatenoi. It is an handsome, populous, trading town; having an abbey of the nuns of St Clair, a commandery of Malta, and several convents of monks and nuns. It is seated in a bottom, in a soil fertile in corn, wine, and all the necessaries of life, on the river Mouzon. E. Long. 5. 45. N. Lat. 48. 20.

NEUFCHATEL, a sovereign county of Switzerland, bounded on the west by the Franche Comte, on the north by the bishopric of Basle, and on the east and south by the cantons of Berne and Friburg; it is about 40 miles in length, and 20 in breadth. It had its own counts for a long time; the last of whom dying in 1694 without issue, it came to Mary of Orleans, duchess of Nemours, his only sister, who died without issue in 1703; there were then 13 competitors; but, at an assembly of the states in 1707, they unanimously chose the king of Prussia for their sovereign, who has placed a governor therein. It is well peopled; and contains three cities, one town, 90 villages, and about 300 houses dispersed in the mountains. The inhabitants are all Protestants, except two Roman Catholic villages; and in 1529 they entered into a strict alliance with the cantons of Berne, Friburg, Soleure, and Lucern. The air is healthy and temperate, but the soil not every where equally fertile; however, there are large vineyards, which produce white and red wine, which last is excellent. The pastures on the mountains feed a great number of all sorts of cattle; and there are plenty of deer in the forests; besides large trouts, and other good fish, in the lakes and rivers. The people are ingenious, polite, active, industrious, and laborious.

NEUFCHATEL, an handsome town of Switzerland, capital of a county of the same name. There are several ancient ruins near it, which shew its former extent; and there are two large churches, besides a castle where the governor resides. It is seated on a lake of the same name, 17 miles in length and five in breadth, and the side of the harbour is the usual walk of the inhabitants. It has a grand and little council: the first is composed of 40 persons, with two masters of the keys; the little council consists of 24 members, comprehending the mayor, who is president. These two councils assemble regularly every month. The ecclesiastics likewise assemble every month, to consult on affairs belonging to the church, and to fill up the places of ministers that die. They choose a dean every year, who is president of the general assemblies, which are called *classes*; and sometimes he is confirmed in this dignity. E. Long. 7. 10. N. Lat. 47. 5.

NEVIS, one of the Caribbee islands, lying about seven leagues north of Montserrat, and separated from St Christopher's by a narrow channel. It makes a beautiful appearance from the sea, being a large conical

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cal mountain covered with fine trees, of an easy ascent on every side, and entirely cultivated. The circumference is about 21 miles, with a considerable tract of level ground all around. The climate in the lower part is reckoned to be warmer than Barbadoes, but it is more temperate towards the summit. The soil is very fine in the lower part, but grows coarser as we ascend. The productions are nearly the same with those of St Christopher. There are three pretty good roads or bays, with small towns in their vicinity; Charles-town, Moreton-Bay, and Newcastle. This pleasant island was settled under the auspices of Sir Thomas Warner from St Christopher's. His successor, governor Lake, was considered as the Solon of this little country, in which he disposed of every thing with such prudence, wisdom, and justice, as procured him an high reputation with the French as well as English. In the Dutch war they met with some disturbance from the French; but by being covered by an English Squadron, the enemy were obliged to desist from their intended invasion, after a smart engagement in fight of the island. Sir William Stapleton sometimes resided here, and Sir Nathaniel Johnson constantly, at which time the inhabitants of Nevis were computed at 30,000. In the war immediately after the revolution, they exerted themselves gallantly, and had two regiments of 300 men each. In that of queen Anne they behaved equally well, tho' they were less fortunate; for the French landing with a superior force, and having invigiled most of their slaves, they were forced to capitulate. About 4000 of these slaves the French carried away and sold to the Spaniards, to work in their mines. The parliament, after making due inquiry into the losses they had sustained, voted them about a third part of the sum in which they had suffered. These losses by war, an epidemic disease, and repeated hurricanes, exceedingly diminished the number of the people. They are now thought not to exceed 2000 or 3000 whites, and 6000 blacks. There is here a lieutenant-governor, with a council, and an assembly, which is composed of three members from each of the five parishes into which the island is divided. The commodities are cotton and sugar; and about 20 sail of ships are annually employed in this trade.

NEURITICS, in pharmacy, medicines good in disorders of the nerves.

NEUROGRAPHY, signifies a description of the nerves. See ANATOMY, n<sup>o</sup> 400.

NEUROPTERA. See ZOOLOGY.

NEUTER, a person indifferent, who has espoused neither party, and is neither friend nor foe.

A judge ought to be neuter in the causes he judges; in questions, where reason appears neuter, a man should ever incline to the side of the unhappy.

NEUTER, in grammar, denotes a sort of gender of nouns, which are neither masculine nor feminine. See GENDER.

The Latins have three kinds of genders, masculine, feminine, and neuter. In English, and other modern tongues, there is no such thing as neuter nouns. See NOUN.

Verbs NEUTER, by some grammarians called *intransitive verbs*, are those which govern nothing, and that are neither active nor positive. See VERB.

When the action expressed by the verb has no object to fall upon, but the verb alone supplies the whole idea of the action; the verb is said to be *neuter*: as, I sleep, thou yawnest, he sneezes, we walk, ye run, they stand still.

Some divide verbs neuter into, 1. Such as do not signify any action, but a quality; as *albet*, "it is white;" or a situation, as *sedet*, "he sits;" or have some relation to place; as *adesit*, "he is present;" or to some other state or attribute, as *regnat*, "he rules," &c. And, 2. Those that do signify actions, though those such as do not pass into any subject different from the actor; as to dine, to sup, to play, &c.

But this latter kind sometimes cease to be *neuter*, and commence active; especially in Greek and Latin, when a subject is given them: as, *vivere vitam, ambulare viam, pugnare pugnam*. Thus the old French poets say, *Sugner son tourment*; the English, *to fight his woes*, &c.

But this is observed only to obtain where something particular is to be expressed, not contained, in the verb: as, *vivere vitam beatam*, to live a happy life; *pugnare bonam pugnam*, to fight a good fight, &c.

According to the abbot de Dangeau, *verbs neuter* may be divided into *active and passive*; the first, those that form their tenses in English, by the auxiliary verb *to have*; in French, by *avoir*. The second, those that form them in English with the verb *to be*; in French *etre*.—Thus, to sleep, to yawn, *dormir* and *etenuer*, are *neuters active*.—To come, and to arrive, are *neuters passive*.

NEUTRAL Salts, among chemists, those compound of an acid with any other substance capable of uniting with it and destroying its acidity. Those in which the acid is saturated with an earth or a metal are called *imperfect*, but those in which a pure alkali is employed are called *perfect*, neutrals.

NEUTRALITY, the state of a person or thing that is neuter, or that takes part with neither side.

NEWCASTLE, the capital of the county of Northumberland in England, a large, populous, and flourishing town, situated on the north bank of the river Tyne, about 300 miles to the northward of London. It is connected, by means of a bridge with the suburbs of Gateshead, which, being on the southern side of the river, is part of the bishopric of Durham. Near the spot where the town now stands, there was of old a fort called *Moncafter*; and Robert, son of William the Conqueror, having built another to overawe the Scots, bestowed upon it the name of *Newcastle*, in contradistinction to the old fortress. Divers monasteries and hospitals being raised around it, the place, in a little time, swelled into a town; and the walls of it were begun in the reign of Edward I. by a rich burgher, who had been taken by the Scots, and paid a large ransom for his liberty. It is at present surrounded by a strong wall, in which there are seven gates and as many turrets, with some casemates said to be bomb-proof. It was created a borough by king Richard II. who granted permission to carry a sword before the mayor; and king Henry VI. erected it into a town and county incorporate, independent of Northumberland. The magistracy consists of a mayor, 19 a'demen, a sheriff, a recorder, a town-clerk, a clerk of the chambers, two coroners, eight chamberlains, a sword-bearer, with a cap

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cap of maintenance, a water-bailiff with a great mace, and seven serjeants at mace. Newcastle has been exposed to frequent incursions and sieges of the Scots, before the union of the two crowns; and in the great rebellion, the army of that kingdom, under the command of Leslie, took it by storm: but it has long ago retrieved all its losses, and become the great emporium of the north of England for coal and other merchandise. The town is built upon the declivity of a hill, which renders the streets steep and incommodious. The houses are crowded together so as to exhibit but a disagreeable appearance: yet one or two of the streets are large, spacious, and well paved. The town is overlooked by the old ruinous castle: the exchange and custom-house are magnificent buildings, but too close to the river; along the bank of which there is a fine key or wharf faced with freestone, to which ships of ordinary burden can carry their broadsides to be loaded or unloaded. But the coal-ships are loaded at or near Shields, seven miles farther down the river; their lading being conveyed thither in lighters, which they call *keels*. The number of the keelmen who work in these lighters, exceed 6000, who live in a suburb called *Sandgate*. They have, by a contribution among themselves, built a noble hospital for such of their poor brethren as are disabled by accident, or superannuated and past labour. The principal church of Newcastle, called *St Nicholas*, is a stately old fabric, built by David king of Scotland, with a fine temple of rare architecture: here are, besides, six churches or chapels. We may number among the public edifices, an elegant mansion-house for the mayor; a noble hall for the surgeons, with a museum; a stately infirmary on the model of that at Edinburgh; a library belonging to the corporation; a large prison called *Newgate*; several meeting-houses, and charity-schools well endowed. The number of inhabitants amounts to above 40,000; and many of them are wealthy, and live with splendour. They are generally bold, rough, and industrious; enriching themselves with the coal-trade, and other branches of commerce and manufacture, such as ship-building, glass-making, salt-works, and hard-ware or wrought iron. The place is particularly famous for grind-stones, which are exported to all the countries in Europe. The fashionable people live in the upper part of the town, at a distance from the river, where they possess elegant houses and gardens, and enjoy themselves at comedies, assemblies, and other polite diversions. The houses are chiefly built of stone, some are of brick, and a very few of timber. The revenue of the town, amounting to 8000*l.* a-year, is considerably larger than that of any other corporation-borough in England: and from this the mayor is indulged with an annual allowance of 600*l.* besides the maintenance of a coach, barge, and mansion-house.

NEWCASTLE (Duke of). See CAVENDISH.

NEWEL, in architecture, is the upright post which a pair of winding stairs turn about; this is properly a cylinder of stone, which bears on the ground, and is formed by the end of the steps of the winding stairs.

NEWFIDLER-SEA, a lake in Hungary, 17 miles in length, and 6 in breadth.

NEWFOREST, a part of Hampshire, lying on

the English channel, opposite to the Isle of Wight. It was made by William the Conqueror, who caused 36 churches, and all the houses belonging thereto, to be pulled down, that there might be no obstruction in hunting the game. It is now appropriated by act of parliament for the production of oaks, to be employed in building the royal navy.

NEWFOUNDLAND, a large island of North America, belonging to Great Britain, lying between 46. 50. and 51. 30. N. Lat. and between 53. 30. and 58. 20. W. Long. from London. The form is that of an irregular triangle, the base or south side being 80 leagues in extent; the east side is the longest; and the whole circumference about 150 leagues. It is bounded on the north by the Straits of Belleisle, which separate it from Labrador; on the east and south it hath the Atlantic Ocean, and on the west the Gulph of St Laurence. The climate is rather severe; and the soil, at least on the sea-coast, which is all that we know of it, is poor and barren. A few kitchen vegetables with strawberries and raspberries are all its produce. The country within land is mountainous, and abounds with timber; there are several rivers which are plentifully stored with various sorts of fish, abundance of deep bays, and many good ports. St John's and Placentia are the two principal settlements, and at each of these there is a fort; the number of people who remain here in the winter hath been computed at 4000. The French, by the treaty of Utrecht, were permitted to fish from Cape Bonavista on the east side round the north of the island to Point Rich on the west; and by the treaty of Paris, they are allowed the isles of St Pierre and Miquelon, upon which they are to dry their fish, but not to erect fortifications of any kind.

The great importance of this place arises from its fishery, which is in part carried on by the inhabitants at the several harbours, which are about 20 in number, who take vast quantities of cod near the coast, which they bring in and cure at their leisure, in order to have it ready for the ships when they arrive. But the great and extensive fishery is on the banks at some distance from the island. The great bank lies 20 leagues from the nearest point of land from the latitude of 41 to 49, stretching 300 miles in length and 75 in breadth. To the east of this lies the False Bank; the next is styled *Vert or the Green Bank*, about 240 miles long, and 120 over; then Banquero, about the same size; the shoals of Sand Island, Whale Bank, and the Bank of St Peter's, with several others of less note, all abounding with fish.

The cod are caught only by a hook, and an expert fisher will take from 150 to 300 and upwards in a day; for the fish never bite in the night, and the labour is very great. The season is from May to October, in the height of which there are from 500 to 700 sail upon the banks at a time. The fish caught in the spring-months are best; they are cured in very different ways. Some are styled *white fish*, others *mud fish*, which are flowed and salted in the hold, and will not keep long; but the best and most valuable are the dried cod. The quantity taken is prodigious; yet in some seasons and in different places varies considerably, as the fish frequently change their stations. The *fishing-ships*, as they are called, lie upon the banks, with the help of

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their boats take and cure their own fish, and as soon as they are full sail for a market. The sack-ships proceed directly to the island, where they purchase fish from the inhabitants either by barter or bills of exchange. The principal markets for cod are Spain, Portugal, Italy, and the West Indies. The value of this fishery is computed at some hundred thousand pounds annually; employing, besides several hundred ships, some thousands of seamen, and affording a maintenance to a number of tradesmen of different occupations, by which many large towns on the west side of England accumulate much wealth, and at the same time contribute in many respects to the benefit of the public.

The great utility of this fishery was very early seen, and very vigorously pursued; for in the beginning of the reign of king James I. we had two hundred and fifty sail employed therein. It is computed, that three quintals of wet fish make one quintal of dried cod. Besides, the fishers of every hundred quintals make a hog/head of oil; and exclusive of these, there are many lesser advantages that go in diminution of the expence. The fishery, as we have said above, produces differently in different seasons; but it is judged to be a very good one when it produces 300,000 quintals of fish, and 3000 barrels of oil, both equally saleable and valuable commodities. As every ship carries 12, and each of their boats eight men, and as these return home in six months, there cannot be a more noble nursery for seamen. The artificers and traders employed in building, victualling, and repairing these vessels, are very numerous in the respective ports from which they sail. These circumstances justify the particular attention paid by government to this branch of the public service; in respect to which, that they may be well informed, an annual and very distinct account, by which the whole is seen at one view, is delivered by the proper officer to the governor of Newfoundland, that is, to the commodore of his majesty's squadron.

NEWMARKET, a town of England, partly in Cambridgeshire, and partly in Suffolk. It consists of one well-built street, seated on the great road, and full of inns. It is chiefly noted for its horse-races. E. Long. o. 25. N. Lat. 52. 16.

NEWT, or EFT, in zoology, the common lizard. See LACERTA.

NEWTON (Sir Isaac), one of the greatest philosophers and mathematicians the world has produced, was the only child of Mr John Newton of Coleworth, not far from Grantham in Lincolnshire, who had an estate of about 120*l.* per annum, which he kept in his own hands. He was born at that place on Christmas-day 1642. His father dying when he was young, his mother's brother, a clergyman of the name of *Ayscough*, or *Askeru*, who lived near her, and directed all her affairs after the death of Mr Newton, put her son to school at Grantham. When he had finished his school-learning, his mother took him home; intending, as she had no other child, to have the pleasure of his company; and that he, as his father had done, should occupy his own estate. But his uncle happening to find him in a hay-loft at Grantham, working a mathematical problem, and having otherwise observed the boy's mind to be uncommonly bent upon learning, he prevailed upon her to part with him; and she sent him

to Trinity College in Cambridge, where her brother, having himself been a member of it, had still many friends. Isaac was soon taken notice of by Dr Isaac Barrow; who, observing his bright genius, contracted a great friendship for him. M. De Fontenelle tells us, "That in learning mathematics he did not study Euclid, who seemed to him too plain and simple, and unworthy of taking up his time. He understood him almost before he read him, and a call of his eye upon the contents of his theorems was sufficient to make him master of them. He advanced at once to the geometry of Des Cartes, Kepler's optics, &c. It is certain, that he had made his great discoveries in geometry, and laid the foundation of his two famous works the *Principia* and the *Optics*, by the time he was 24 years of age."

In 1664, he took the degree of bachelor of arts; and in 1668 that of master, being elected the year before fellow of his college. He had before this time discovered the method of fluxions; and in 1669, he was chosen professor of mathematics in the university of Cambridge, upon the resignation of Dr Barrow. The same year, and the two following, he read a course of optical lectures in Latin, in the public schools of the university; an English translation of which was printed at London in 1728 in 8vo, as was the Latin original the next year in 4to. From the year 1671 to 1679, he held a correspondence, by letters, with Mr Henry Oldenburg, secretary of the royal society, and Mr John Collins, fellow of that society; which letters contain a variety of curious observations.

Concerning the origin of his discoveries, we are told that as he sat alone in a garden, the falling of some apples from a tree led him into a speculation on the power of gravity; that as this power is not diminished at the remotest distance from the centre of the earth to which we can rise, it appeared to him reasonable to conclude, that it must extend much farther than was usually thought; and pursuing this speculation by comparing the periods of the several planets with their distances from the sun, he found, that if any power like gravity held them in their courses, its strength must decrease in the duplicate proportion of the increase of distance. This inquiry was dropped; but resumed again, and gave rise to his writing the treatise which he published in 1687 under the name of *Mathematical Principles of Natural Philosophy*; a work looked upon as the production of a celestial intelligence rather than of a man. The very same year in which this great work was published, the university of Cambridge was attacked by king James II. when he was one of its most zealous defenders, and was accordingly nominated one of the delegates of that university to the high-commission court; and the next year he was chosen one of their members for the convention-parliament, in which he sat till it was dissolved. In 1696, Mr Montague, then chancellor of the exchequer, and afterwards earl of Halifax, obtained for him of the king, the office of warden of the mint; in which employment he was of signal service, when the money was called in to be recoined. Three years after, he was appointed master of the mint; a place of very considerable profit, which he held till his death. In 1699, he was elected one of the members of the royal academy

Newton.

demy of sciences at Paris. In 1701, he was a second time chosen member of parliament for the university of Cambridge. In 1704, he published his *Optics*; which is a piece of philosophy so new, that the science may be considered as entirely owing to our author. In 1705, he was knighted by queen Anne. In 1707, he published his *Arithmetica Universalis*. In 1711, his *Analyses per Quantitatum Series, Fluxiones et Differentias*, &c. was published by William Jones Esq. In 1712, several letters of his were published in the *Commercium Epistolicum*. In the reign of George I. he was better known at court than before. The prince of Wales, afterwards queen-consort of England, used frequently to propose questions to him, and to declare that she thought herself happy to live at the same time with him, and have the pleasure and advantage of his conversation. He had written a treatise of ancient chronology, which he did not think of publishing; but the prince desired an abstract, which he would never part with. However, a copy of it stole abroad, and was carried into France; where it was translated and printed, with some observations, which were afterwards answered by Sir Isaac. But, in 1728, the Chronology itself was published at London in quarto; and was attacked by several persons, and as zealously defended by Sir Isaac's friends. The main design of it was to find out, from some tracts of the most ancient Greek astronomy, what was the position of the colours with respect to the fixed stars, in the time of Chiron the centaur. As it is now known that these stars have a motion in longitude of one degree in 72 years, if it is once known thro' what fixed stars the colour passed in Chiron's time, by taking the distance of these stars from those through which it now passes, we might determine what number of years is elapsed since Chiron's time. As Chiron was one of the Argonauts, this would fix the time of that famous expedition, and consequently that of the Trojan war; the two great events upon which all the ancient chronology depends. Sir Isaac places them 500 years nearer the birth of Christ than other chronologists generally do.

This great man had all along enjoyed a settled and equal state of health to the age of 80, when he began to be afflicted with an incontinence of urine. However, for the five following years, he had great intervals of ease, which he procured by the observance of a strict regimen. It was then believed that he certainly had the stone; and when the paroxysms were so violent, that large drops of sweat ran down his face, he never uttered the least complaint, or expressed the smallest degree of impatience; but, as soon as he had a moment's ease, would smile and talk with his usual cheerfulness. Till then he always read and wrote several hours in a day. He had the perfect use of all his senses and understanding till the day before he died, which was on the 20th of March 1726-7, in the 85th year of his age.—He lay in state in the Jerusalem chamber at Westminster, and on the 28th of March his body was conveyed into Westminster abbey; the pall being supported by the lord chancellor, the dukes of Montrose and Roxburgh, and the earls of Pembroke, Suffolk, and Macclesfield. The bishop of Rochester read the funeral office, being attended by all the clergy of the church. The corps was interred

Newton.

just at the entrance into the choir, where a noble monument is erected to his memory.

Sir Isaac was of a middling stature, and in the latter part of his life somewhat inclined to be fat. His countenance was pleasing, and at the same time venerable. He never made use of spectacles, and lost but one tooth during his whole life.

His temper is said to have been so equal and mild, that no accident could disturb it. Of this the following remarkable instance is related. Sir Isaac had a favourite little dog, which he called *Diamond*; and being one day called out of his study into the next room, *Diamond* was left behind. When Sir Isaac returned, having been absent but a few minutes, he had the mortification to find, that *Diamond* having thrown down a lighted candle among some papers, the nearly finished labour of many years was in flames, and almost consumed to ashes. This loss, as Sir Isaac was then very far advanced in years, was irretrievable; yet, without once striking the dog, he only rebuked him with this exclamation, "Oh! *Diamond!* *Diamond!* thou little knowest the mischief thou hast done!"

He was a great lover of peace; and would rather have chosen to remain in obscurity, than to have the calm of life ruffled by those storms and disputes which genius and learning always draw upon those that are too eminent for them. In contemplating his genius, it presently becomes a doubt, which of these endowments had the greatest share, sagacity, penetration, strength, or diligence: and, after all, the mark that seems most to distinguish it is, that he himself made the justest estimation of it, declaring, that, if he had done the world any service, it was due to nothing but industry and patient thought; that he kept the subject under consideration constantly before him, and waited till the first dawning opened gradually, by little and little, into a full and clear light. It is said, that when he had any mathematical problems or solutions in his mind, he would never quit the subject on any account. Dinner has been often three hours ready for him before he could be brought to table: that his man often said, when he has been getting up in a morning, he has sometimes begun to dress, and with one leg in his breeches, sat down again on the bed, where he has remained for hours before he got his cloaths on. From his love of peace, no doubt, arose that unusual kind of horror which he had for all disputes; a steady unbroken attention, free from those frequent recoils inseparably incident to others, was his peculiar felicity; he knew it, and he knew the value of it. No wonder then that controversy was looked on as his bane. When some objections, hastily made to his discoveries concerning light and colours, induced him to lay aside the design he had of publishing his optic lectures; we find him reflecting on that dispute, into which he was unavoidably drawn thereby, in these terms: "I blamed my own imprudence for parting with so real a blessing as my quiet, to run after a shadow." It is true this shadow, as Mr Fontenelle observes, did not escape him afterwards, nor did it cost him that quiet which he so much valued, but proved as much a real happiness to him as his quiet itself; yet this was a happiness of his own making; he took a resolution, from these disputes, not to publish any more about that theory, till he had put it above the reach

of



of controversy, by the exactest experiments, and the strictest demonstrations; and accordingly it has never been called in question since. In the same temper, after he had sent the manuscript of his *Principia* to the Royal Society, with his consent to the printing of it by them; yet upon Mr Hooke's injuriously insinuating that himself had demonstrated Kepler's problem before our author, he determined, rather than be involved again in a controversy, to suppress the third book, and was very hardly prevailed upon to alter that resolution. It is true, the public was thereby a gainer; that book, which is indeed no more than a corollary of some propositions in the first, being originally drawn up in the popular way, with a design to publish it in that form; whereas he was now convinced that it would be best not to let it go abroad without a strict demonstration.

After all, notwithstanding his anxious care to avoid every occasion of breaking his intense application to study, he was at a great distance from being steeped in philosophy: on the contrary, he could lay aside his thoughts, though engaged in the most intricate researches, when his other affairs required his attendance; and, as soon as he had leisure, resume the subject at the point where he had left off. This he seems to have done not so much by any extraordinary strength of memory, as by the force of his inventive faculty, to which every thing opened itself again with ease, if nothing intervened to ruffle him. The readiness of his invention made him not think of putting his memory much to the trial; but this was the offspring of a vigorous intenseness of thought, out of which he was but a common man. He spent, therefore, the prime of his age in those abstruse researches, when his situation in a college gave him leisure, and even while study was his proper profession. But, as soon as he was removed to the mint, he applied himself chiefly to the business of that office; and so far quitted mathematics and philosophy, as not to engage in any pursuits of either kind afterwards.

The amiable quality of modesty is represented as standing foremost in the character of this great man's mind and manners. It was in reality greater than can be easily imagined, or will be readily believed: yet it always continued so without any alteration, though the whole world, says Fontenelle, conspired against it; let us add, though he was thereby robbed of his invention of fluxions. Nicholas Mercator publishing his *Logarithmotechnia* in 1668, where he gave the quadrature of the hyperbola by an infinite series, which was the first appearance in the learned world of a series of this sort drawn from the particular nature of the curve, and that in a manner very new and abstracted; Dr Barrow, then at Cambridge, where Mr Newton, then about 26 years of age, resided, recollected, that he had met with the same thing in the writings of that young gentleman; and there not confined to the hyperbola only, but extended, by general forms, to all sorts of curves, even such as are mechanical; to their quadratures, their rectifications, and their centres of gravity; to the solids formed by their relations, and to the superficies of those solids; so that, when their determinations were possible, the series stopped at a certain point, or at least their sums were given by stated rules; and, if the absolute determinations were impossible, they could yet be infinitely approximated; which is

the happiest and most refined method, says Mr Fontenelle, of supplying the defects of human knowledge that man's imagination could possibly invent. To be master of so fruitful and general a theory was a mine of gold to a geometrician; but it was a greater glory to have been the discoverer of so surprising and ingenious a system. So that Mr Newton, finding by Mercator's book, that he was in the way to it, and that others might follow in his track, should naturally have been forward to open his treasures, and secure the property, which consisted in making the discovery; but he contented himself with his treasure which he had found, without regarding the glory. What an idea does it give us of his unparalleled modesty, when we see him declaring, that he thought Mercator had intirely discovered his secret, or that others would, before he was of a proper age for writing? His MS. upon infinite series was communicated to none but Mr John Collins and the Lord Brouncker; and even that had not been complied with, but for Dr Barrow, who would not suffer him to indulge his modesty so much as he desired.

It is further observed, concerning this part of his character, that he never talked either of himself or others, nor ever behaved in such a manner as to give the most malicious censurers the least occasion even to suspect him of vanity. He was candid and affable, and always put himself upon a level with his company. He never thought either his merit or his reputation sufficient to excuse him from any of the common offices of social life; no singularities, either natural or affected, distinguished him from other men. Though he was firmly attached to the church of England, he was averse to the persecution of the non-conformists. He judged of men by their manners; and the true schismatics, in his opinion, were the vicious and the wicked. Not that he confined his principles to natural religion, for he was thoroughly persuaded of the truth of revelation; and amidst the great variety of books which he had constantly before him, that which he studied with the greatest application was the Bible; and he understood the nature and force of moral certainty as well as he did that of a strict demonstration.

Sir Isaac did not neglect the opportunities of doing good, when the revenues of his patrimony, and a profitable employment, improved by a prudent economy, put it in his power. We have two remarkable instances of his bounty and generosity; one to Mr M-Laurin, professor of mathematics at Edinburgh, to whom he offered 20l. per annum; and the other to his niece Barton, who had an annuity of 100l. per annum settled upon her by him. When decency upon any occasion required expence and shew, he was magnificent without grudging it, and with a very good grace; at all other times, that pomp which seems great to low minds only, was utterly retrenched, and the expence reserved for better uses. He never married, and perhaps he never had leisure to think of it. Being immersed in profound studies during the prime of his age, and afterwards engaged in an employment of great importance, and even quite taken up with the company which his merit drew to him, he was not sensible of any vacancy in life, nor of the want of a companion at home. He left 32,000l. at his death; but made no will, which is

Mr

Newtonian  
Philosophy

Mr Fontenelle tells us was because he thought a legacy was no gift. As to his works, besides what were published in his life-time, there were found after his death, among his papers, several discourses upon the subjects of antiquity, history, divinity, chemistry, and mathematics, several of which were published at different times.

NEWTONIAN *Philosophy*, the doctrine of the universe, and particularly of the heavenly bodies, their laws, affections, &c. as delivered by Sir Isaac Newton.

Different o-  
pinions  
concerning  
this philo-  
sophy.

The term *Newtonian philosophy* is applied very differently; whence divers confused notions relating thereto.—Some authors, under this philosophy, include all the corpufcular philosophy, considered as it now stands corrected and reformed by the discoveries and improvements made in several parts thereof by Sir Isaac Newton. In which sense it is that Gravefande calls his elements of physics, *Introductio ad Philosophiam Newtonianam*. And in this sense the Newtonian is the same with the new philosophy; and stands contradicting with the Cartesian, the Peripatetic, and the ancient Corpufcular.

Others, by *Newtonian philosophy*, mean the method or order which Sir Isaac Newton observes in philosophizing; viz. the reasoning and drawing of conclusions directly from phenomena, exclusive of all previous hypotheses; the beginning from simple principles; deducing the first powers and laws of nature from a few select phenomena, and then applying those laws, &c. to account for other things. And in this sense the *Newtonian philosophy* is the same with the *experimental philosophy*, and stands opposed to the ancient *Corpufcular*.

Others, by *Newtonian philosophy*, mean that wherein physical bodies are considered mathematically, and where geometry and mechanics are applied to the solution of phenomena. In which sense the Newtonian is the same with the *mechanical and mathematical philosophy*.

Others again, by *Newtonian philosophy*, understand that part of physical knowledge which Sir Isaac Newton has handled, improved, and demonstrated, in his *Principia*.

Others, lastly, by *Newtonian philosophy*, mean the new principles which Sir Isaac Newton has brought into philosophy; the new system founded thereon; and the new solutions of phenomena thence deduced; or that which characterizes and distinguishes his philosophy from all others.—Which is the sense wherein we shall chiefly consider it.

As to the history of this philosophy, we have nothing to add to what has been given in the preceding article. It was first made public in the year 1687, by the author, then a fellow of Trinity-college, Cambridge; and in the year 1713, republished with considerable improvements.—Several authors have since attempted to make it plainer; by setting aside many of the more sublime mathematical researches, and substituting either more obvious reasonings or experiments in lieu thereof; particularly Whiston in his *Prælect. Phys. Mathematicæ*. Gravefande in *Element. & Vssit.* and Dr Pemberton in his *View*.

The whole of the *Newtonian philosophy*, as delivered by the author, is contained in his *Principia*, or *Mathematical Principles of Natural Philosophy*. He founds

his system on the following definitions.

Newtonian  
Philosophy

1. The quantity of matter is the measure of the same, arising from its density and bulk conjunctly.—  
Thus air of a double density, in a double space, is the quadruple in quantity; in a triple space, sextuple in quantity, &c.

Definitions  
on which  
the philo-  
sophy is  
founded.

2. The quantity of motion is the measure of the same, arising from the velocity and quantity of matter conjunctly. This is evident, because the motion of the whole is the motion of all its parts; and therefore in a body double in quantity, with equal velocity, the motion is double, &c.

3. The *vis insita*, or innate force of matter, is a power of resisting, by which every body, as much as it lies, endeavours to persevere in its present state, whether it be of rest, or moving uniformly forward in a right line.—This definition is proved to be just, only by the difficulty we find in moving any thing out of its place; and this difficulty is by some reckoned to proceed only from gravity. They contend, that in those cases where we can prevent the force of gravity from acting upon bodies, this power of resistance becomes insensible, and the greatest quantities of matter may be put in motion by the very least force. Thus there have been balances formed so exact, that when loaded with 200 weight in each scale, they would turn by the addition of a single drachm. In this case 400 lb. of matter was put in motion by a single drachm, i. e. by  $\frac{1}{271360}$  parts of its own quantity; and even this small weight, they say, is only necessary on account of the inaccuracy of the machine; so that we have no reason to suppose, that, if the friction could be entirely removed, it would take more force to move a ton weight than a grain of sand. This objection, however, is not taken notice of by Sir Isaac; and he bestows on the resisting power abovementioned, the name of *vis inertiae*.

4. An impressed force is an action exerted upon a body, in order to change its state, either of rest, or of moving uniformly forward in a right line.—This force consists in the action only; and remains no longer in the body when the action is over. For a body maintains every new state it acquires by its *vis inertiae* only.

5. A centripetal force is that by which bodies are drawn, impelled, or any way tend towards a point, as to a centre.—The quantity of any centripetal force may be considered as of three kinds, absolute, accelerative, and motive.

6. The absolute quantity of a centrifugal force is the measure of the same, proportional to the efficacy of the cause that propagates it from the centre, through the spaces round about.

7. The accelerative quantity of a centripetal force is the measure of the same, proportional to the velocity which it generates in a given time.

8. The motive quantity of a centripetal force is a measure of the same, proportional to the motion which it generates in a given time.—This is always known by the quantity of a force equal and contrary to it, that is just sufficient to hinder the descent of the body.

SCHOLIA.  
I. Absolute, true, and mathematical time, of itself, and from its own nature, flows equally, without regard

3  
*Vis insita*  
defined and  
objected to.

4

Newtonian  
philosophy

gard to any thing external, and, by another name, is called *duration*. Relative, apparent, and common time, is some sensible and external measure of duration, whether accurate or not, which is commonly used instead of true time; such as an hour, a day, a month, a year, &c.

5  
pace.

II. Absolute space, in its own nature, without regard to any thing external, remains always similar and immovable. Relative space is some moveable dimension or measure of the absolute spaces; and which is vulgarly taken for immovable space. Such is the dimension of a subterraneous, an aerial, or celestial space, determined by its position to bodies, and which is vulgarly taken for immovable space; as the distance of a subterraneous, an aerial, or celestial space, determined by its position in respect of the earth. Absolute and relative space are the same in figure and magnitude; but they do not remain always numerically the same. For if the earth, for instance, moves, a space of our air which, relatively and in respect of the earth, remains always the same, will at one time be one part of the absolute space into which the air passes; at another time it will be another part of the same; and so, absolutely understood, it will be perpetually mutable.

6  
Place defined.

III. Place is a part of space which a body takes up; and is, according to the space, either absolute or relative. Our author says it is *part of space*; not the situation, nor the external surface of the body. For the places of equal solids are always equal; but their superficies, by reason of their dissimilar figures, are often unequal. Positions properly have no quantity, nor are they so much the places themselves as the properties of places. The motion of the whole is the same thing with the sum of the motions of the parts; that is, the translation of the whole out of its place is the same thing with the sum of the translations of the parts out of their places: and therefore the place of the whole is the same thing with the sum of the places of the parts; and for that reason it is internal, and in the whole body.

7  
Of motion.

IV. Absolute motion is the translation of a body from one absolute place into another, and relative motion the translation from one relative place into another. Thus, in a ship under sail, the relative place of a body is that part of the ship which the body possesses, or that part of its cavity which the body fills, and which therefore moves together with the ship; and relative rest is the continuance of the body in the same part of the ship, or of its cavity. But real absolute rest is the continuance of the body in the same part of that immovable space in which the ship itself, its cavity, and all that it contains, is moved. Wherefore, if the earth is really at rest, the body which relatively rests in the ship will really and absolutely move with the same velocity which the ship has on the earth. But if the earth also moves, the true and absolute motion of the body will arise, partly from the true motion of the earth in immovable space; partly from the relative motion of the ship on the earth: and if the body moves also relatively in the ship, its true motion will arise partly from the true motion of the earth in immovable space, and partly from the relative motions as well of the ship on the earth, as of the body in the ship; and from these relative mo-

Newtonian  
Philosophy

tions will arise the relative motion of the body on the earth. As if that part of the earth where the ship is, was truly moved towards the east, with a velocity of 1000 parts; while the ship itself with a fresh gale is carried towards the west, with a velocity expressed by 10 of these parts; but a sailor walks in the ship towards the east with one part of the said velocity; then the sailor will be moved truly and absolutely in immovable space towards the east with a velocity of 1001 parts; and relatively on the earth towards the west, with a velocity of 9 of those parts.

Absolute time, in astronomy, is distinguished from relative, by the equation or correction of the vulgar time. For the natural days are truly unequal, though they are commonly considered as equal, and used for a measure of time: astronomers correct this inequality for their more accurate deducing of the celestial motions. It may be that there is no such thing as an equable motion whereby time may be accurately measured. All motions may be accelerated or retarded; but the true or equable progress of absolute time is liable to no change. The duration or perseverance of the existence of things remains the same, whether the motions are swift or slow, or none at all; and therefore ought to be distinguished from what are only sensible measures thereof, and out of which we collect it by means of the astronomical equation. The necessity of which equation for determining the times of a phenomenon is evinced, as well from the experiments of the pendulum-clock, as by eclipses of the satellites of Jupiter.

8  
Immutability of time and space.

As the order of the parts of time is immutable, also is the order of the parts of space. Suppose those parts to be moved out of their places, and they will be moved (if we may be allowed the expression) out of themselves. For times and spaces are, as it were, the places of themselves as of all other things. All things are placed in time as to order of succession; and in space as to order of situation. It is from their essence or nature that they are places; and that the primary places of things should be moveable, is absurd. These are therefore the absolute places; and translations out of those places are the only absolute motions.

But because the parts of space cannot be seen, or distinguished from one another by the senses, therefore in their read we use sensible measures of them. For, from the positions and distances of things from any body, considered as immovable, we define all places; and then with respect to such places, we estimate all motions, considering bodies as transferred from some of those places into others. And so, instead of absolute places and motions, we use relative ones; and that without any inconvenience in common affairs: but in philosophical disquisitions we ought to abstract from our senses, and consider things themselves distinct from what are only sensible measures of them. For it may be, that there is no body really at rest, to which the places and motions of others may be referred.

But we may distinguish rest and motion, absolute and relative, one from the other by their properties, causes, and effects. It is a property of rest, that bodies really at rest do rest in respect of each other. And therefore, as it is possible, that, in the remote re-

gions

gions of the fixed stars, or perhaps far beyond them, there may be some body absolutely at rest, but impossible to know from the position of bodies to one another in our regions, whether any of these do keep the same position to that remote body; it follows, that absolute rest cannot be determined from the position of bodies in our regions.

9  
Of the motion of different bodies with respect to one another.

It is a property of motion, that the parts which retain given positions to their wholes do partake of the motions of their wholes. For all parts of revolving bodies endeavour to recede from the axis of motion; and the impetus of bodies moving forwards arises from the joint impetus of all the parts. Therefore if surrounding bodies are moved, those that are relatively at rest within them will partake of their motion. Upon which account the true and absolute motion of a body cannot be determined by the translation of it from those only which seem to rest; for the external bodies ought not only to appear at rest, but to be really at rest. For otherwise all included bodies, beside their translation from near the surrounding ones, partake likewise of their true motions; and though that translation was not made, they would not really be at rest, but only seem to be so. For the surrounding bodies stand in the like relation to the surrounded, as the exterior part of a whole does to the interior, or as the shell does to the kernel; but if the shell moves, the kernel will also move, as being part of the whole, without any removal from near the shell.

A property near akin to the preceding is, that if a place is moved, whatever is placed therein moves along with it; and therefore a body which is moved from a place in motion, partakes also of the motion of its place. Upon which account all motions from places in motion, are no other than parts of entire and absolute motions; and every entire motion is composed out of the motion of the body out of its first place, and the motion of this place out of its place; and so on, until we come to some immovable place, as in the above-mentioned example of the sailor. Wherefore entire and absolute motions can be no otherwise determined than by immovable places. Now, no other places are immovable but those that from infinity to infinity do all retain the same given positions one to another; and upon this account must ever remain unmoved, and do thereby constitute what we call *immoveable space*.

The causes by which true and relative motions are distinguished one from the other, are the forces impressed upon bodies to generate motion. True motion is neither generated nor altered, but by some force impressed upon the body moved: but relative motion may be generated or altered without any force impressed upon the body. For it is sufficient only to impress some force on other bodies with which the former is compared, that, by their giving way, that relation may be changed, in which the relative rest or motion of the other body did consist. Again, true motion suffers always some change from any force impressed upon the moving body; but relative motion does not necessarily undergo any change by such force. For if the same forces are likewise impressed on those other bodies with which the comparison is made, that the relative position may be preserved; then that con-

dition will be preserved; in which the relative motion consists. And therefore any relative motion may be changed when the true motion remains unaltered, and the relative may be preserved when the true motion suffers some change. Upon which account true motion does by no means consist in such relations.

The effects which distinguish absolute from relative motion are, the forces of receding from the axis of circular motion. For there are no such forces in a circular motion purely relative: but, in a true and absolute circular motion, they are greater or less according to the quantity of the motion. If a vessel, hung by a long cord, is so often turned about that the cord is strongly twisted, then filled with water, and let go, it will be whirled about the contrary way; and while the cord is untwisting itself, the surface of the water will at first be plain, as before the vessel began to move; but the vessel, by gradually communicating its motion to the water, will make it begin sensibly to revolve, and recede by little and little from the middle, and ascend to the sides of the vessel, forming itself into a concave figure; and the swifter the motion becomes, the higher will the water rise, till at last, performing its revolutions in the same times with the vessel, it becomes relatively at rest in it. This ascent of the water shews its endeavour to recede from the axis of its motion; and the true and absolute circular motion of the water, which is here directly contrary to the relative, discovers itself, and may be measured by this endeavour. At first, when the relative motion in the water was greatest, it produced no endeavour to recede from the axis; the water shewed no tendency to the circumference, nor any ascent towards the sides of the vessel, but remained of a plain surface; and therefore its true circular motion had not yet begun. But afterwards, when the relative motion of the water had decreased, the ascent thereof towards the sides of the vessel, proved its endeavour to recede from the axis; and this endeavour shewed the real circular motion of the water perpetually increasing, till it had acquired its greatest quantity, when the water rested relatively in the vessel. And therefore this endeavour does not depend upon any translation of the water in respect of the ambient bodies; nor can true circular motion be defined by such translations. There is only one real circular motion of any one revolving body, corresponding to only one power of endeavouring to recede from its axis of motion, as its proper and adequate effect: but relative motions in one and the same body are innumerable, according to the various relations it bears to external bodies; and, like other relations, are altogether destitute of any real effect, otherwise than they may perhaps participate of that only true motion. And therefore, in the system which supposes that our heavens, revolving below the sphere of the fixed stars, carry the planets along with them, the several parts of those heavens and the planets, which are indeed relatively at rest in their heavens, do yet really move. For they change their position one to another, which never happens to bodies truly at rest; and being carried together with the heavens, participate of their motions, and, as parts of revolving wholes, endeavour to recede from the axis of their motion.

10  
Absolute and relative motion distinguished.

Wherefore relative quantities are not the quantities themselves whose names they bear, but those sensible

Newtonian  
PhilosophyNewtonian  
Philosophy

measures of them, either accurate or inaccurate, which are commonly used instead of the measured quantities themselves. And then, if the meaning of words is to be determined by their use, by the names *time*, *space*, *place*, and *motion*, their measures are properly to be understood; and the expression will be unusual and purely mathematical, if the measured quantities themselves are meant.

It is indeed a matter of great difficulty to discover, and effectually to distinguish, the true motions of particular bodies from those that are only apparent: because the parts of that immovable space in which those motions are performed, do by no means come under the observation of our senses. Yet we have some things to direct us in this intricate affair; and these arise partly from the apparent motions which are the difference of the true motions, partly from the forces which are the causes and effects of the true motions. For instance, if two globes, kept at a given distance one from the other by means of a cord that connects them, were revolved about their common centre of gravity; we might, from the tension of the cord, discover the endeavour of the globes to recede from the axis of motion, and from thence we might compute the quantity of their circular motions. And then, if any equal forces should be impressed at once on the alternate faces of the globes to augment or diminish their circular motions, from the increase or decrease of the tension of the cord we might infer the increment or decrement of their motions; and thence would be found on what faces those forces ought to be impressed, that the motions of the globes might be most augmented; that is, we might discover their hindermost faces, or those which follow in the circular motion. But the faces which follow being known, and consequently the opposite ones that precede, we should likewise know the determination of their motions. And thus we might find both the quantity and determination of this circular motion, even in an immense vacuum, where there was nothing external or sensible, with which the globes might be compared. But now, if in that space some remote bodies were placed that kept always a given position one to another, as the fixed stars do in our regions; we could not indeed determine from the relative translation of the globes among those bodies, whether the motion did belong to the globes or to the bodies. But if we observed the cord, and found that its tension was that very tension which the motions of the globes required, we might conclude the motion to be in the globes, and the bodies to be at rest; and then, lastly, from the translation of the globes among the bodies, we should find the determination of their motions.

Having thus explained himself, Sir Isaac proposes to show how we are to collect the true motions from their causes, effects, and apparent directions; and *vice versa*, how, from the motions, either true or apparent, we may come to the knowledge of their causes and effects. In order to this, he lays down the following axioms or laws of motion.

1. Every body perseveres in its state of rest, or of uniform motion in a right line, unless it is compelled to change that state by forces impressed upon it.—Sir Isaac's proof of this axiom is as follows: "Projectiles persevere in their motions, so far as they are not re-

tarded by the resistance of the air, or impelled downwards by the force of gravity. A top, whose parts, by their cohesion, are perpetually drawn aside from rectilinear motions, does not cease its rotation otherwise than as it is retarded by the air. The greater bodies of the planets and comets, meeting with less resistance in more free spaces, preserve their motions, both progressive and circular, for a much longer time."—Notwithstanding this demonstration, however, the axiom hath been violently disputed. It hath been argued, that bodies continue in their state of motion because they are subjected to the continual impulse of an invisible and subtle fluid, which always pours in from behind, and of which all places are full. They affirm that motion is as natural to this fluid as rest is to all other matter. They say, moreover, that it is impossible we can know in what manner a body would be influenced by moving forces if it was entirely destitute of gravity. According to what we can observe, the momentum of a body, or its tendency to move, depends very much on its gravity. A heavy cannon-ball will fly to a much greater distance than a light one, though both are actuated by an equal force. It is by no means clear therefore, that a body totally destitute of gravity would have any proper momentum of its own; and if it had no momentum, it could not continue its motion for the smallest space of time after the moving power was withdrawn. Some have imagined that matter was capable of beginning motion of itself, and consequently that the axiom was false; because we see plainly that matter in some cases hath a tendency to change from a state of motion to a state of rest, and from a state of rest to a state of motion. A paper appeared on this subject in the first volume of the Edinburgh Physical and Literary Essays; but the hypothesis never gained any ground.

2. The alteration of motion is ever proportional to the motive force impressed; and is made in the direction of the right line in which that force is impressed. Thus, if any force generates a certain quantity of motion, a double force will generate a double quantity, whether that force be impressed all at once, or in successive moments.

3. To every action there is always opposed an equal re-action; or the mutual actions of two bodies upon each other are always equal, and directed to contrary parts.—This axiom is also disputed by many. In the abovementioned paper in the Physical Essays, the author endeavours to make a distinction between re-action and resistance; but this cannot be sufficiently explained, and therefore the hypothesis hath not been adopted. Others grant that Sir Isaac's axiom is very true in respect to terrestrial substances; but they affirm, that, in these, both action and re-action are the effects of gravity. Substances void of gravity would have no momentum; and without this they could not act; they would be moved by the least force, and therefore could not resist or re-act. If therefore there is any fluid which is the cause of gravity, though such fluid could act upon terrestrial substances, yet these could not re-act upon it; because they have no force of their own, but depend entirely upon it for their momentum. In this manner, say they, we may conceive that the planets circulate, and all the operations of nature are carried on by means of a subtle fluid; which being per-

<sup>13</sup>  
Laws of  
motion.

<sup>14</sup>  
Objections  
to the third  
law.

Newtonian  
Philosophy

fectly active, and the rest of matter altogether passive, there is neither resistance, nor loss of motion.

From the preceding axiom Sir Isaac draws the following corollaries.

1. A body by two forces conjoined will describe the diagonal of a parallelogram in the same time that it would describe the sides by those forces apart.

2. Hence we may explain the composition of any one direct force out of any two oblique ones, viz. by making the two oblique forces the sides of a parallelogram, and the direct one the diagonal.

3. The quantity of motion, which is collected by taking the sum of the motions directed towards the same parts, and the difference of those that are directed to contrary parts, suffers no change from the action of bodies among themselves; because the motion which one body loses is communicated to another; and if we suppose friction and the resistance of the air to be absent, the motion of a number of bodies which mutually impelled one another would be perpetual, and its quantity always equal.

4. The common centre of gravity of two or more bodies does not alter its state of motion or rest by the actions of the bodies among themselves; and therefore the common centre of gravity of all bodies acting upon each other (excluding outward actions and impediments) is either at rest, or moves uniformly in a right line.

5. The motions of bodies included in a given space are the same among themselves, whether that space is at rest, or moves uniformly forward in a right line without any circular motion. The truth of this is evidently shewn by the experiment of a ship; where all motions happen after the same manner, whether the ship is at rest, or proceeds uniformly forward in a straight line.

6. If bodies, any how moved among themselves, are urged in the direction of parallel lines by equal accelerative forces, they will all continue to move among themselves, after the same manner as if they had been urged by no such forces.

The whole of the mathematical part of the Newtonian philosophy depends on the following lemmas; of which the first is the principal.

LEM. I. Quantities, and the ratios of quantities, which in any finite time converge continually to equality, and before that time approach nearer the one to the other than by any given difference, become ultimately equal. If you deny it; suppose them to be ultimately unequal, and let D be their ultimate difference. Therefore they cannot approach nearer to equality than by that given difference D; which is against the supposition.

Concerning the meaning of this lemma philosophers are not agreed; and unhappily it is the very fundamental position on which the whole of the system rests. Many objections have been raised to it by people who supposed themselves capable of understanding it. They say, that it is impossible we can come to an end of any infinite series, and therefore that the word *ultimate* can in this case have no meaning. In some cases the lemma is evidently false. Thus, suppose there are two quantities of matter A and B, the one containing half a pound, and the other a third part of one. Let both be continually divided by 2; and though their

Newtonian  
Philosophy

ratio, or the proportion of the one to the other, doth not vary, yet the difference between them perpetually becomes less, as well as the quantities themselves, until both the difference and quantities themselves become less than any assignable quantity; yet the difference will never totally vanish, nor the quantities become equal, as is evident from the two following series.

$$\begin{matrix} \frac{1}{2} & \frac{1}{4} & \frac{1}{8} & \frac{1}{16} & \frac{1}{32} & \frac{1}{64} & \frac{1}{128} & \frac{1}{256} & \frac{1}{512} & \frac{1}{1024} & \text{&c.} \\ \frac{1}{2} & \frac{1}{4} & \frac{1}{8} & \frac{1}{16} & \frac{1}{32} & \frac{1}{64} & \frac{1}{128} & \frac{1}{256} & \frac{1}{512} & \frac{1}{1024} & \text{&c.} \\ \text{Diff.} & \frac{1}{4} & \frac{1}{8} & \frac{1}{16} & \frac{1}{32} & \frac{1}{64} & \frac{1}{128} & \frac{1}{256} & \frac{1}{512} & \frac{1}{1024} & \text{&c.} \end{matrix}$$

Thus we see, that though the difference is continually diminishing, and that in a very large proportion, there is no hope of its vanishing, or the quantities becoming equal. In like manner, let us take the proportions or ratios of quantities, and we shall be equally unsuccessful. Suppose two quantities of matter, one containing 8 and the other 10 pounds; these quantities already have to each other the ratio of 8 to 10, or of 4 to 5; but let us add 2 continually to each of them, and though the ratios continually come nearer to that of equality, it is in vain to hope for a perfect coincidence. Thus,

$$8 \quad 10 \quad 12 \quad 14 \quad 16 \quad 18 \quad 20 \quad 22 \quad 24, \text{ &c.}$$

$$10 \quad 12 \quad 14 \quad 16 \quad 18 \quad 20 \quad 22 \quad 24 \quad 26, \text{ &c.}$$

$$\text{Ratio } \frac{4}{5} \quad \frac{6}{7} \quad \frac{8}{9} \quad \frac{7}{8} \quad \frac{9}{10} \quad \frac{10}{11} \quad \frac{11}{12}, \text{ &c.}$$

For this and his other lemmas Sir Isaac makes the following apology. "These lemmas are premised, to avoid the tediousness of deducing perplexed demonstrations *ad absurdum*, according to the method of ancient geometers. For demonstrations are more contracted by the method of indivisibles: but because the hypothesis of indivisibles seems somewhat harsh, and therefore that method is reckoned less geometrical, I chose rather to reduce the demonstrations of the following propositions to the first and last sums and ratios of nascent and evanescent quantities, that is, to the limits of those sums and ratios; and so to premise, as short as I could, the demonstrations of those limits. For hereby the same thing is performed as by the method of indivisibles; and now those principles being demonstrated, we may use them with more safety. Therefore, if hereafter I should happen to consider quantities as made up of particles, or should use little curve lines for right ones; I would not be understood to mean indivisibles, but evanescent divisible quantities; nor the sums and ratios of determinate parts, but always the limits of sums and ratios; and that the force of such demonstrations always depends on the method laid down in the foregoing lemmas.

"Perhaps it may be objected, that there is no ultimate proportion of evanescent quantities, because the proportion before the quantities have vanished, is not the ultimate, and, when they are vanished, is none. But by the same argument it may be alleged, that a body arriving at a certain place, and there stopping, has no ultimate velocity; because the velocity before the body comes to the place is not its ultimate velocity; when it is arrived, it has none. But the answer is easy: for by the ultimate velocity is meant that with which the body is moved, neither before it arrives at its place and the motion ceases, nor after; but at the very instant it arrives; that is, that velocity with which the body arrives at its last place, and with which the motion ceases. And in like manner, by the ultimate ratio of evanescent quantities is to be understood

Answered.

16  
Objections to the first lemma.

understood the ratio of the quantities, not before they vanish, nor afterwards, but with which they vanish. Newtonian Philosophy

In like manner, the first ratio of nascent quantities is that with which they begin to be. And the first or last sum is that with which they begin and cease to be (or to be augmented and diminished). There is a limit which the velocity at the end of the motion may attain, but not exceed; and this is the ultimate velocity. And there is the like limit in all quantities and proportions that begin and cease to be. And, since such limits are certain and definite, to determine the same is a problem strictly geometrical. But whatever is geometrical we may be allowed to make use of in determining and demonstrating any other thing that is likewise geometrical.

“It may be also objected, that if the ultimate ratios of evanescent quantities are given, their ultimate magnitudes will also be given; and so all quantities will consist of indivisibles, which is contrary to what Euclid has demonstrated concerning incommensurables, in the 10th book of his Elements. But this objection is founded on a false supposition. For those ultimate ratios with which quantities vanish are not truly the ratios of ultimate quantities, but limits towards which the ratios of quantities decreasing continually approach.”

LEM. II. If in any figure  $AacE$  (Pl. CCIV. fig. 2.) terminated by the right line  $Aa$ ,  $AE$ , and the curve  $a c E$ , there be inscribed any number of parallelograms  $Ab$ ,  $Bc$ ,  $Cd$ , &c. comprehended under equal bases  $AB$ ,  $BC$ ,  $CD$ , &c. and the sides  $Bb$ ,  $Cc$ ,  $Dd$ , &c. parallel to one side  $Aa$  of the figure; and the parallelograms  $aKb$ ,  $bLc$ ,  $cMdn$ , &c. are completed. Then if the breadth of those parallelograms be supposed to be diminished, and their number augmented in *infinitum*; the ultimate ratios which the inscribed figure  $A K b L c M d n$ , the circumscribed figure  $A a b m c n d o E$ , and curvilinear figure  $A a b c d E$ , will have to one another, are ratios of equality. —For the difference of the inscribed and circumscribed figures is the sum of the parallelograms  $Kb$ ,  $Lm$ ,  $Mn$ ,  $Do$ ; that is, (from the equality of all their bases), the rectangle under one of their bases  $Kb$ , and the sum of their altitudes  $Aa$ , that is, the rectangle  $ABla$ . But this rectangle, because its breadth  $AB$  is supposed diminished in *infinitum*, becomes less than any given space. And therefore, by lem. 1. the figures inscribed and circumscribed become ultimately equal the one to the other; and much more will the intermediate curvilinear figure be ultimately equal to either.

LEM. III. The same ultimate ratios are also ratios of equality, when the breadths  $AB$ ,  $BC$ ,  $DC$ , &c. of the parallelograms are unequal, and are all diminished in *infinitum*. —The demonstration of this differs but little from that of the former.

In his succeeding lemmas, Sir Isaac goes on to prove, in a manner similar to the above, that the ultimate ratios of the sine, chord, and tangent of arcs infinitely diminished, are ratios of equality, and therefore that in all our reasonings about these we may safely use the one for the other: —that the ultimate form of evanescent triangles made by the arc, chord, and tangent, is that of similitude, and their ultimate ratio is that of equality; and hence, in reasonings about

ultimate ratios, we may safely use these triangles for each other, whether made with the sine, the arc, or the tangent. —He then shews some properties of the ordinates of curvilinear figures; and proves that the spaces which a body describes by any finite force urging it, whether that force is determined and immutable, or is continually augmented or continually diminished, are, in the very beginning of the motion, one to the other in the duplicate ratio of the powers. And lastly, having added some demonstrations concerning the evanescence of angles of contact, he proceeds to lay down the mathematical part of his system, and which depends on the following theorems.

THEOR. I. The areas which revolving bodies describe by radii drawn to an immoveable centre of force, lie in the same immoveable planes, and are proportional to the times in which they are described. —For, suppose the time to be divided into equal parts, and in the first part of that time, let the body by its innate force describe the right line  $AB$  (fig. 3.); in the second part of that time, the same would, by law 1. if not hindered, proceed directly to  $c$  along the line  $Bc = AB$ ; so that by the radii  $AS$ ,  $BS$ ,  $cS$ , drawn to the centre, the equal areas  $ASB$ ,  $BS c$ , would be described. But, when the body is arrived at  $B$ , suppose the centripetal force acts at once with a great impulse, and, turning aside the body from the right line  $Bc$ , compels it afterwards to continue its motion along the right line  $BC$ . Draw  $cC$  parallel to  $BS$ , meeting  $BC$  in  $C$ ; and at the end of the second part of the time, the body, by cor. 1. of the laws, will be found in  $C$ , in the same plane with the triangle  $ASB$ . Join  $SC$ ; and because  $SB$  and  $cC$  are parallel, the triangle  $SBC$  will be equal to the triangle  $SBC$ , and therefore also to the triangle  $SAB$ . By the like argument, if the centripetal force acts successively in  $C$ ,  $D$ ,  $E$ , &c. and makes the body in each single particle of time to describe the right lines  $CD$ ,  $DE$ ,  $EF$ , &c. they will all lie in the same plane; and the triangle  $SCD$  will be equal to the triangle  $SBC$ , and  $SDE$  to  $SCD$ , and  $SEF$  to  $SDE$ . And therefore, in equal times, equal areas are described in one immoveable plane; and, by composition, any sums  $SADS$ ,  $SAFS$ , of those areas are, one to the other, as the times in which they are described. Now, let the number of those triangles be augmented, and their size diminished in *infinitum*; and then, by the preceding lemmas, their ultimate perimeter  $ADF$  will be a curve line: and therefore the centripetal force by which the body is perpetually drawn back from the tangent of this curve will act continually; and any described areas  $SADS$ ,  $SAFS$ , which are always proportional to the times of description, will, in this case also, be proportional to those times.  $Q. E. D.$

COR. 1. The velocity of a body attracted towards an immoveable centre, in spaces void of resistance is reciprocally as the perpendicular let fall from that centre on the right line which touches the orbit. For the velocities in these places  $A$ ,  $B$ ,  $C$ ,  $D$ ,  $E$ , are as the bases  $AB$ ,  $BC$ ,  $DE$ ,  $EF$ , of equal triangles; and these bases are reciprocally as the perpendiculars let fall upon them.

COR. 2. If the chords  $AB$ ,  $BC$ , of two arcs successively described in equal times by the same body, in spaces void of resistance, are completed into a

parallelogram ABCV, and the diagonal BV of this parallelogram, in the position which it ultimately acquires when those arcs are diminished in *infinitum* is produced both ways, it will pass through the centre of force.

COR. 3. If the chords AB, BC, and DE, EF, of arcs described in equal times, in spaces void of resistance are completed into the parallelograms ABCV, DEFZ, the forces in B and E are one to the other in the ultimate ratio of the diagonals BV, EZ, when those arcs are diminished in *infinitum*. For the motions BC and EF of the body (by cor. 1. of the laws), are compounded of the motions Bc, BV and Ef, EZ; but BV and EZ, which are equal to Cc and Ff, in the demonstration of this proposition, were generated by the impulses of the centripetal force in B and E, and are therefore proportional to those impulses.

COR. 4. The forces by which bodies, in spaces void of resistance, are drawn back from rectilinear motions, and turned into curvilinear orbits, are one to another as the versed lines of arcs described in equal times; which versed lines tend to the centre of force, and bisect the chords when these arcs are diminished to infinity. For such versed lines are the halves of the diagonals mentioned in cor. 3.

COR. 5. And therefore those forces are to the force of gravity, as the said versed lines to the versed lines perpendicular to the horizon of those parabolic arcs which projectiles describe in the same time.

COR. 6. And the same things do all hold good (by cor. 5. of the laws) when the planes in which the bodies are moved, together with the centres of force, and where they are placed in those planes, are not at rest, but move uniformly forward in right lines.

THEOR. II. Every body that moves in any curve line described in a plane, and, by a radius drawn to a point either immovable or moving forward with a uniform rectilinear motion, describes about that point areas proportional to the times, is urged by a centripetal force directed to that point.

CASE I. For every body that moves in a curve line is (by law 1.) turned aside from its rectilinear course by the action of some force that impels it; and that force by which the body is turned off from its rectilinear course, and made to describe in equal times the least equal triangles SAB, SBC, SCD, &c. about the immovable point S, (by Prop. 40. E. 1. and law 2.) acts in the place B according to the direction of a line parallel to C; that is, in the direction of the line BS; and in the place C according to the direction of a line parallel to d D, that is, in the direction of the line CS, &c.; and therefore acts always in the direction of lines tending to the immovable point S. Q. E. D.

CASE II. And (by cor. 5. of the laws) it is indifferent whether the superficies in which a body describes a curvilinear figure be quiescent, or moves together with the body, the figure described, and its point S, uniformly forward in right lines.

COR. 1. In non-resisting spaces or mediums, if the areas are not proportional to the times, the forces are not directed to the point in which the radii meet; but deviate therefrom in *consequentia*, or towards the parts to which the motion is directed, if the description of the areas is accelerated; but in *antecess*.

*dentia* if retarded.

COR. 2. And even in resisting mediums, if the description of the areas is accelerated, the directions of the forces deviate from the point in which the radii meet, towards the parts to which the motion tends.

#### SCHOLIUM.

A body may be urged by a centripetal force compounded of several forces. In which case the meaning of the proposition is, that the force which results out of all tends to the point S. But if any force acts perpetually in the direction of lines perpendicular to the described surface, this force will make the body to deviate from the plane of its motion, but will neither augment nor diminish the quantity of the described surface; and is therefore not to be neglected in the composition of forces.

THEOR. III. Every body that, by a radius drawn to the centre of another body, howsoever moved, describes areas about that centre proportional to the times, is urged by a force compounded out of the centripetal forces tending to that other body, and of all the accelerative force by which that other body is impelled.—The demonstration of this is a natural consequence of the theorem immediately preceding.

Hence, if the one body L, by a radius drawn to the other body T, describes areas proportional to the times, and from the whole force by which the first body L is urged, (whether that force is simple, or, according to cor. 2. of the laws, compounded out of several forces), we subduct that whole accelerative force by which the other body is urged; the whole remaining force by which the first body is urged will tend to the other body T, as its centre.

And *vice versa*, if the remaining force tends nearly to the other body T, those areas will be nearly proportional to the times.

If the body L, by a radius drawn to the other body T, describes areas, which, compared with the times, are very unequal; and that other body T be either at rest, or moves uniformly forward in a right line, the action of the centripetal force tending to that other body T is either none at all, or it is mixed and combined with very powerful actions of other forces: and the whole force compounded of them all, if they are many, is directed to another (immovable or moveable) centre. The same thing obtains when the other body is actuated by any other motion whatever; provided that centripetal force is taken which remains after subducting that whole force acting upon that other body T.

#### SCHOLIUM.

Because the equable description of areas indicates that a centre is respected by that force with which the body is most affected, and by which it is drawn back from its rectilinear motion, and retained in its orbit, we may always be allowed to use the equable description of areas as an indication of a centre about which all circular motion is performed in free spaces.

THEOR. IV. The centripetal forces of bodies which by equable motions describe different circles, tend to the centres of the same circles; and are one to the other as the squares of the arcs described in equal times applied to the radii of circles.—For these forces tend



tend to the centres of the circles, (by theor. 2. and cor. 2. theor. 1.) and arc to one another as the versed sines of the least arcs described in equal times, (by cor. 4. theor. 1.) that is, as the squares of the same arcs applied to the diameters of the circles, by one of the lemmas; and therefore, since those arcs are as arcs described in any equal times, and the diameters are as the radii, the forces will be as the squares of any arcs described in the same time, applied to the radii of the circles. Q. E. D.

COR. 1. Therefore, since those arcs are as the velocities of the bodies, the centripetal forces are in a ratio compounded of the duplicate ratio of the velocities directly, and of the simple ratio of the radii inversely.

COR. 2. And since the periodic times are in a ratio compounded of the ratio of the radii directly, and the ratio of the velocities inversely; the centripetal forces are in a ratio compounded of the ratio of the radii directly, and the duplicate ratio of the periodic times inversely.

COR. 3. Whence, if the periodic times are equal, and the velocities therefore as the radii, the centripetal forces will be also as the radii; and the contrary.

COR. 4. If the periodic times and the velocities are both in the subduplicate ratio of the radii, the centripetal forces will be equal among themselves; and the contrary.

COR. 5. If the periodic times are as the radii, and therefore the velocities equal, the centripetal forces will be reciprocally as the radii; and the contrary.

COR. 6. If the periodic times are in the sesquialtate ratio of the radii, and therefore the velocities reciprocally in the subduplicate ratio of the radii, the centripetal forces will be in the duplicate ratio of the radii inversely; and the contrary.

COR. 7. And universally, if the periodic time is as any power  $R^n$  of the radius  $R$ , and therefore the velocity reciprocally as the power  $R^{n-1}$  of the radius, the centripetal force will be reciprocally as the power  $R^{2n-2}$  of the radius; and the contrary.

COR. 8. The same things all hold concerning the times, the velocities, and forces, by which bodies describe the similar parts of any similar figures, that have their centres in a similar position within those figures, as appears by applying the demonstrations of the preceding cases to those. And the application is easy, by only substituting the equable description of areas in the place of equable motion, and using the distances of the bodies from the centres instead of the radii.

COR. 9. From the same demonstration it likewise follows, that the arc which a body uniformly revolving in a circle by means of a given centripetal force describes in any time, is a mean proportional between the diameter of the circle, and the space which the same body, falling by the same given force, would descend through in the same given time.

“By means of the preceding proposition and its corollaries, (says Sir Isaac), we may discover the proportion of a centripetal force to any other known force, such as that of gravity. For if a body by means of its gravity revolves in a circle concentric to the

earth, this gravity is the centripetal force of that body. But from the descent of heavy bodies, the time of one entire revolution, as well as the arc described in any given time, is given (by cor. 9. of this theorem). And by such propositions Mr Huygens, in his excellent book *De Horologio Oscillatorio*, has compared the force of gravity with the centrifugal forces of revolving bodies.

The preceding proposition may also be demonstrated in the following manner. In any circle suppose a polygon to be inscribed of any number of sides. And if a body, moved with a given velocity along the sides of the polygon, is reflected from the circle at the several angular points; the force with which, at every reflection, it strikes the circle will be as its velocity: and therefore the sum of the forces, in a given time, will be as that velocity and the number of reflections conjunctly; that is, (if the species of the polygon be given), as the length described in that given time, and increased or diminished in the ratio of the same length to the radius of the circle; that is, as the square of that length applied to the radius; and therefore, if the polygon, by having its sides diminished in infinitum, coincides with the circle, as the square of the arc described in a given time applied to the radius. This is the centrifugal force, with which the body impels the circle; and to which the contrary force, wherewith the circle continually repels the body towards the centre, is equal.

On these principles hangs the whole of Sir Isaac Newton's mathematical philosophy. He now shews how to find the centre to which the forces impelling any body are directed, having the velocity of the body given: and finds the centrifugal force to be always as the versed sine of the nascent arc directly, and as the square of the time inversely; or directly as the square of the velocity, and inversely as the chord of the nascent arc. From these premises he deduces the method of finding the centripetal force directed to any given point when the body revolves in a circle; and this whether the central point is near or at an immense distance; so that all the lines drawn from it may be taken for parallels. The same thing he shews with regard to bodies revolving in spirals, ellipses, hyperbolas, or parabolas.—Having the figures of the orbits given, he shews also how to find the velocities and moving powers; and, in short, solves all the most difficult problems relating to the celestial bodies with an astonishing degree of mathematical skill. These problems and demonstrations are all contained in the first book of the *Principia*: but to give an account of them here would exceed our limits; neither would many of them be intelligible, excepting to first-rate mathematicians.

In the second book Sir Isaac treats of the properties of fluids, and their powers of resistance; and here he lays down such principles as entirely overthrow the doctrine of Des Cartes's vortices, which was the fashionable system in his time. In the third book, he begins particularly to treat of the natural phenomena, and apply to them the mathematical principles formerly demonstrated; and, as a necessary preliminary to this part, he lays down the following rules for reasoning in natural philosophy.

1. We are to admit no more causes of natural things

Newtonian  
Philosophy

things than such as are both true and sufficient to explain their natural appearances.

2. Therefore to the same natural effects we must always assign, as far as possible, the same causes.

3. The qualities of bodies which admit neither intension nor remission of degrees, and which are found to belong to all bodies within the reach of our experiments, are to be esteemed the universal qualities of all bodies whatsoever.

4. In experimental philosophy, we are to look upon propositions collected by general induction from phenomena as accurately or very nearly true, notwithstanding any contrary hypotheses that may be imagined, till such time as other phenomena occur, by which they may either be made more accurate, or liable to exceptions.

The phenomena first considered, are, 1. That the satellites of Jupiter by radii drawn to the centre of their primary, describe areas proportional to the times of their description; and that their periodic times, the fixed stars being at rest, are in the sesquialterate ratio of their distances from its centre. 2. The same thing is likewise observed of the phenomena of Saturn. 3. The five primary planets, Mercury, Venus, Mars, Jupiter, and Saturn, with their several orbits, encompass the sun. 4. The fixed stars being supposed at rest, the periodic times of the five primary planets, and of the earth, about the sun, are in the sesquialterate proportion of their mean distances from the sun. 5. The primary planets, by radii drawn to the earth, describe areas no ways proportionable to the times: but the areas which they describe by radii drawn to the sun are proportional to the times of description. 6. The moon, by a radius drawn to the centre of the earth, describes an area proportional to the time of description. All these phenomena are undeniable from astronomical observations, and are explained at large under the article *ASTRONOMY*. The mathematical demonstrations are next applied by Sir Isaac Newton in the following propositions.

**PROP. I.** The forces by which the Satellites of Jupiter are continually drawn off from rectilinear motions, and retained in their proper orbits, tend to the centre of that planet; and are reciprocally as the squares of the distances of those satellites from that centre. The former part of this proposition appears from theor. 2. or 3. and the latter from cor. 6. of theor. 5.; and the same thing we are to understand of the satellites of Saturn.

**PROP. II.** The forces by which the primary planets are continually drawn off from rectilinear motions, and retained in their proper orbits, tend to the sun; and are reciprocally as the squares of the distances from the sun's centre. The former part of this proposition is manifest from phenomenon 5. just mentioned, and from theor. 2.; the latter from phenom. 4. and cor. 6. of theor. 4. But this part of the proposition is with great accuracy deducible from the quiescence of the apheleon points. For a very small aberration from the reciprocal duplicate proportion would produce a motion of the apides, sensible in every single revolution, and in many of them enormously great.

**PROP. III.** The force by which the moon is retained in its orbit, tends towards the earth; and is reciprocally as the square of the distance of its place from

the centre of the earth. The former part of this proposition is evident from phenom. 5. and theor. 2.; the latter from phenom. 6. and theor. 2. or 3. It is also evident from the very slow motion of the moon's apogee; which, in every single revolution, amounting but to  $3^{\circ} 3'$  in *consequantia*, may be neglected: and this more fully appears from the next proposition.

**PROP. IV.** The moon gravitates towards the earth, and by the force of gravity is continually drawn off from a rectilinear motion, and retained in its orbit.—The mean distance of the moon from the earth in the syzgies in semidiameters of the latter, is about  $60\frac{1}{2}$ . Let us assume the mean distance of 60 semidiameters in the syzgies; and suppose one revolution of the moon in respect of the fixed stars to be completed in  $27^{\text{d}}. 7^{\text{h}}. 43'$ , as astronomers have determined; and the circumference of the earth to amount to 123,249,600 Paris feet. Now, if we imagine the moon, deprived of all motion, to be let go, so as to descend towards the earth with the impulse of all that force by which it is retained in its orbit, it will, in the space of one minute of time, describe in its fall  $15\frac{1}{2}$  Paris feet. For the veried sine of that arc which the moon, in the space of one minute of time, describes by its mean motion at the distance of 60 semidiameters of the earth, is nearly  $15\frac{1}{2}$  Paris feet; or more accurately, 15 feet 1 inch and 1 line  $\frac{2}{3}$ . Wherefore since that force, in approaching to the earth, increases in the reciprocal duplicate proportion of the distance; and, upon that account, at the surface of the earth is  $60 \times 60$  times greater than at the moon; a body in our regions, falling with that force, ought, in the space of one minute of time, to describe  $60 \times 60 \times 15\frac{1}{2}$  Paris feet; and in the space of one second of time to describe  $15\frac{1}{2}$  of those feet; or, more accurately, 15 feet 1 inch, 1 line  $\frac{2}{3}$ . And with this very force we actually find that bodies here on earth do really descend. For a pendulum oscillating seconds in the latitude of Paris, will be three Paris feet and  $8\frac{1}{2}$  lines in length, as Mr Huygens has observed. And the space which a heavy body describes by falling one second of time, is to half the length of the pendulum in the duplicate ratio of the circumference of the circle to its diameter; and is therefore 15 Paris feet, 1 inch, 1 line  $\frac{2}{3}$ . And therefore the force by which the moon is retained in its orbit, becomes, at the very surface of the earth, equal to the force of gravity which we observe in heavy bodies there. And therefore (by rule 1. and 2.) the force by which the moon is retained in its orbit is that very same force which we commonly call *gravity*. For were gravity another force different from that, then bodies descending to the earth with the joint impulse of both forces, would fall with a double velocity, and, in the space of one second of time, would describe  $30\frac{2}{3}$  Paris feet; altogether against experience.

The demonstration of this proposition may be more diffusely explained after the following manner. Suppose several moons to revolve about the earth, as in the system of Jupiter or Saturn, the periodic times of those moons would (by the argument of induction) observe the same law which Kepler found to obtain among the planets; and therefore their centripetal forces would be reciprocally as the squares of the distances from the centre of the earth by Prop. I. Now, if the

Newtonian  
Philosophy

the lowest of these were very small, and were so near the earth as almost to touch the tops of the highest mountains, the centripetal force thereof, retaining it in its orbit, would be very nearly equal to the weights of any terrestrial bodies that should be found upon the tops of these mountains; as may be known from the foregoing calculation. Therefore if the same little moon should be deferted by its centrifugal force that carries it through its orb, it would descend to the earth; and that with the same velocity as heavy bodies do actually descend with upon the tops of those very mountains, because of the equality of forces that oblige them both to descend. And if the force by which that lowest moon would descend were different from that of gravity, and if that moon were to gravitate towards the earth, as we find terrestrial bodies do on the tops of mountains, it would then descend with twice the velocity, as being impelled by both these forces conspiring together. Therefore, since both these forces, that is, the gravity of heavy bodies, and the centripetal forces of the moons, respect the centre of the earth, and are similar and equal between themselves, they will (by rule 1. and 2.) have the same cause. And therefore the force which retains the moon in its orbit, is that very force which we commonly call *gravity*; because otherwise this little moon at the top of a mountain must either be without gravity, or fall twice as swiftly as heavy bodies use to do.

Having thus demonstrated that the moon is retained in its orbit by its gravitation towards the earth, it is easy to apply the same demonstration to the motions of the other secondary planets, and of the primary planets round the sun, and thus to shew that gravitation prevails throughout the whole creation; after which, Sir Isaac proceeds to shew from the same principles, that the heavenly bodies gravitate towards each other, and contain different quantities of matter, or have different densities in proportion to their bulks.

PROP. V. All bodies gravitate towards every planet; and the weights of bodies towards the same planet at equal distances from its centre, are proportional to the quantities of matter they contain.

It has been confirmed by many experiments, that all sorts of heavy bodies (allowance being made for the inequality of retardation by some small resistance of the air) descend to the earth from equal heights in equal times; and that equality of times we may distinguish to a great accuracy, by the help of pendulums. Sir Isaac Newton tried the thing in gold, silver, lead, glass, sand, common salt, wood, water, and wheat. He provided two wooden boxes, round and equal, filled the one with wood, and suspended an equal weight of gold in the centre of oscillation of the other. The boxes hanging by equal threads of 11 feet, made a couple of pendulums, perfectly equal in weight and figure, and equally receiving the resistance of the air. And placing the one by the other, he observed them to play together forwards and backwards, for a long time, with equal vibrations. And therefore the quantity of matter in the gold was to the quantity of matter in the wood, as the action of the motive force (or *vis motrix*) upon all the gold, to the action of the same upon all the wood; that is, as the weight of the one to the weight of the other. And the like happened in the other bodies. By these experi-

ments, in bodies of the same weight, he could manifestly have discovered a difference of matter less than the thousandth part of the whole, had any such been. But, without all doubt, the nature of gravity towards the planets, is the same as towards the earth. For, should we imagine our terrestrial bodies removed to the orb of the moon, and there, together with the moon, deprived of all motion, to be let go, so as to fall together towards the earth; it is certain, from what we have demonstrated before, that, in equal times, they would describe equal spaces with the moon, and of consequence are to the moon, in quantity of matter, as their weights to its weight. Moreover, since the satellites of Jupiter perform their revolutions in times which observe the sesquuplicate proportion of their distances from Jupiter's centre, their accelerative gravities towards Jupiter will be reciprocally as the squares of their distances from Jupiter's centre; that is, equal at equal distances. And therefore, these satellites, if supposed to fall towards Jupiter from equal heights, would describe equal spaces in equal times, in like manner as heavy bodies do on our earth. And by the same argument, if the circumfolar planets were supposed to be let fall at equal distances from the sun, they would, in their descent towards the sun, describe equal spaces in equal times. But forces, which equally accelerate unequal bodies, must be as those bodies; that is to say, the weights of the planets towards the sun must be as their quantities of matter. Further, that the weights of Jupiter and of his satellites towards the sun are proportional to the several quantities of their matter, appears from the exceeding regular motions of the satellites. For if some of those bodies were more strongly attracted to the sun in proportion to their quantity of matter than others, the motions of the satellites would be disturbed by that inequality of attraction. If, at equal distances from the sun, any satellite, in proportion to the quantity of its matter, did gravitate towards the sun, with a force greater than Jupiter in proportion to his, according to any given proportion, suppose of  $d$  to  $e$ ; then the distance between the centres of the sun and of the satellite's orbit would be always greater than the distance between the centres of the sun and of Jupiter, nearly in the subduplicate of that proportion. And if the satellite gravitated towards the sun with a force, lesser in the proportion of  $d$  to  $d$ , the distance of the centre of the satellite's orb from the sun, would be less than the distance of the centre of Jupiter's from the sun, in the subduplicate of the same proportion. Therefore, if, at equal distances from the sun, the accelerative gravity of any satellite towards the sun, were greater or less than the accelerating gravity of Jupiter towards the sun, but by one  $\frac{1}{10000}$  part of the whole gravity; the distance of the centre of the satellite's orbit from the sun would be greater or less than the distance of Jupiter from the sun, by one  $\frac{1}{10000}$  part of the whole distance; that is, by a fifth part of the distance of the utmost satellite from the centre of Jupiter; an eccentricity of the orbit, which would be very sensible. But the orbits of the satellites are concentric to Jupiter; therefore the accelerative gravities of Jupiter, and of all its satellites, towards the sun, are equal among themselves. And by the same argument, the weight of Saturn and of his satellites towards the sun, at equal distances from the sun, are as their several quantities.

Newtonian  
Philosophy of matter; and the weights of the moon and of the earth towards the sun, are either none, or accurately proportional to the masses of matter which they contain.

*inertia* are in the proportion of their bulks.]  
PROP. VI. That there is a power of gravity tending to all bodies, proportional to the several quantities of matter which they contain.

Newtonian  
Philosophy

But further, the weights of all the parts of every planet towards any other planet, are one to another as the matter in the several parts. For if some parts gravitate more, others less, than for the quantity of their matter; then the whole planet, according to the fort of parts with which it most abounds, would gravitate more or less, than in proportion to the quantity of matter in the whole. Nor is it of any moment whether these parts are external or internal. For if, for example, we should imagine the terrestrial bodies with us to be raised up to the orb of the moon, to be there compared with its body; if the weights of such bodies were to the weights of the external parts of the moon, as the quantities of matter in the one and in the other respectively; but to the weights of the internal parts, in a greater or less proportion; then likewise the weights of those bodies would be to the weight of the whole moon, in a greater or less proportion; against what we have shewed above.

COR. 1. Hence the weights of bodies do not depend upon their forms and textures. For if the weights could be altered with the forms, they would be greater or less, according to the variety of forms in equal matter; altogether against experience.

COR. 2. Universally, all bodies about the earth gravitate towards the earth; and the weights of all, at equal distances from the earth's centre, are as the quantities of matter which they severally contain. This is the quality of all bodies within the reach of our experiments; and therefore (by rule 3.) to be affirmed of all bodies whatsoever. If the ether, or any other body, were either altogether void of gravity, or were to gravitate less in proportion to its quantity of matter; then, because (according to Aristotle, Des Cartes, and others) there is no difference betwixt that and other bodies, but in mere form of matter, by a successive change from form to form, it might be changed at last into a body of the same condition with those which gravitate most in proportion to their quantity of matter; and, on the other hand, the heaviest bodies, acquiring the first form of that body, might by degrees quite lose their gravity. And therefore the weights would depend upon the forms of bodies, and with those forms might be changed, contrary to what was proved in the preceding corollary.

COR. 3. All spaces are not equally full. For if all spaces were equally full, then the specific gravity of the fluid which fills the region of the air, on account of the extreme density of the matter, would fall nothing short of the specific gravity of quick-silver, or gold, or any other the most dense body; and therefore, neither gold, nor any other body, could descend in air. For bodies do not descend in fluids, unless they are specifically heavier than the fluids. And if the quantity of matter in a given space can by any rarefaction be diminished, what should hinder a diminution to infinity?

COR. 4. If all the solid particles of all bodies are of the same density, nor can be rarefied without pores, a void space or vacuum must be granted. [By bodies of the same density, our author means those whose *vires*

That all the planets mutually gravitate one towards another, we have proved before; as well as that the force of gravity towards every one of them, considered apart, is reciprocally as the square of the distance of places from the centre of the planet. And thence it follows, that the gravity tending towards all the planets, is proportional to the matter which they contain.

Moreover, since all the parts of any planet *A* gravitate towards any other planet *B*; and the gravity of every part is to the gravity of the whole, as the matter of the part to the matter of the whole; and (by law 3.) to every action corresponds an equal re-action: therefore the planet *B* will, on the other hand, gravitate towards all the parts of the planet *A*; and its gravity towards any one part will be to the gravity towards the whole, as the matter of the part to the matter of the whole. Q. E. D.

COR. 1. Therefore the force of gravity towards any whole planet, arises from, and is compounded of, the forces of gravity towards all its parts. Magnetic and electric attractions afford us examples of this. For all attraction towards the whole arises from the attractions towards the several parts. The thing may be easily understood in gravity, if we consider a greater planet as formed of a number of lesser planets, meeting together in one globe. For hence it would appear that the force of the whole must arise from the forces of the component parts. If it be objected, That, according to this law, all bodies with us must mutually gravitate one towards another, whereas no such gravitation any where appears; it is answered, That since the gravitation towards these bodies is to the gravitation towards the whole earth, as these bodies are to the whole earth, the gravitation towards them must be far less than to fall under the observation of our senses. [The experiments with regard to the attraction of mountains, however, have now further elucidated this point.]

COR. 2. The force of gravity towards the several equal particles of any body, is reciprocally as the square of the distance of places from the particles.

PROP. VII. In two spheres mutually gravitating each towards the other, if the matter, in places on all sides round about and equidistant from the centres, is similar; the weight of either sphere towards the other, will be reciprocally as the square of the distance between their centres.

For the demonstration of this, see the *Principia*, book i. prop. 75 and 76.

COR. 1. Hence we may find and compare together the weights of bodies towards different planets. For the weights of bodies revolving in circles about planets, are as the diameters of the circles directly, and the squares of their periodic times reciprocally; and their weights at the surfaces of the planets, or at any other distances from their centres, are (by this prop.) greater or less, in the reciprocal duplicate proportion of the distances. Thus from the periodic times of Venus, revolving about the sun, in  $224^d. 16^h$ ; of the utmost circumjovial satellite revolving about Jupiter, in  $16^d. 16^h$ ; of the Huygenian satellite about Saturn in  $15^d. 22^h$ ; and of the moon about the earth in  $27^d. 7^h$ .

7<sup>th</sup>. 43'; compared with the mean distance of Venus from the sun, and with the greatest heliocentric elongations of the outmost circumjovial satellite from Jupiter's centre, 8' 16"; of the Huygenian satellite from the centre of Saturn, 3' 4"; and of the moon from the earth, 10' 33"; by computation our author found, that the weight of equal bodies, at equal distances from the centres of the sun, of Jupiter, of Saturn, and of the earth, towards the sun, Jupiter, Saturn, and the earth, were one to another, as  $\frac{1}{10000}$ ,  $\frac{1}{997}$ ,  $\frac{1}{791}$ , and  $\frac{1}{109}$  respectively. Then, because, as the distances are increased or diminished, the weights are diminished or increased in a duplicate ratio; the weights of equal bodies towards the sun, Jupiter, Saturn, and the earth, at the distances 10000, 997, 791, and 109, from their centres, that is, at their very superficies, will be as 10000, 943, 529, and 435 respectively.

Cor. 2. Hence likewise we discover the quantity of matter in the several planets. For their quantities of matter are as the forces of gravity at equal distances from their centres, that is, in the sun, Jupiter, Saturn, and the earth, as 1,  $\frac{1}{10000}$ ,  $\frac{1}{997}$ , and  $\frac{1}{791}$  respectively. If the parallax of the sun be taken greater or less than 10" 30", the quantity of matter in the earth must be augmented or diminished in the triplicate of that proportion.

Cor. III. Hence also we find the densities of the planets. For (by prop. 72. book 1.) the weights of equal and similar bodies towards similar spheres, are, at the surfaces of those spheres, as the diameters of the spheres. And therefore the densities of dissimilar spheres are as those weights applied to the diameters of the spheres. But the true diameters of the sun, Jupiter, Saturn, and the earth, were one to another as 10000, 997, 791, and 109; and the weights towards the same, as 10000, 943, 529, and 435 respectively; and therefore their densities are as 100, 943, 67, and 400. The density of the earth, which comes out by this computation, does not depend upon the parallax of the sun, and is determined by the parallax of the moon, and therefore is here truly defined. The sun therefore is a little denser than Jupiter, and Jupiter than Saturn, and the earth four times denser than the sun; for the sun, by its great heat, is kept in a sort of a rarified state. The moon is denser than the earth.

Cor. 4. The smaller the planets are, they are, *cæteris paribus*, of so much the greater density. For so the powers of gravity on their several surfaces come nearer to equality. They are likewise, *cæteris paribus*, of the greater density as they are nearer to the sun. So Jupiter is more dense than Saturn, and the earth than Jupiter. For the planets were to be placed at different distances from the sun, that, according to their degrees of density, they might enjoy a greater or less proportion of the sun's heat. Our water, if it were removed as far as the orb of Saturn, would be converted into ice, and in the orb of Mercury would quickly fly away in vapour. For the light of the sun, to which its heat is proportional, is seven times denser in the orb of Mercury than with us: and by the thermometer Sir Isaac found, that a sevenfold heat of our summer-sun will make water boil. Nor are we to doubt, that the matter of Mercury is adapted to its heat, and is therefore more dense than the matter of

our earth; since, in a denser matter, the operations of Niagara nature require a stronger heat.

It is shewn in the scholium of prop. 22. book 2. of the *Principia*, that at the height of 200 miles above the earth, the air is more rare than it is at the superficies of the earth, in the ratio of 30 to 0,0000000000003998, or as 7500000000000 to 1 nearly. And hence the planet Jupiter, revolving in a medium of the same density with that superior air, would not lose by the resistance of the medium the 1000000th part of its motion in 1000000 years. In the spaces near the earth, the resistance is produced only by the air, exhalations, and vapours. When these are carefully exhausted by the air-pump from under the receiver, heavy bodies fall within the receiver with perfect freedom, and without the least sensible resistance; gold itself, and the lightest down, let fall together, will descend with equal velocity; and though they fall through a space of four, six, and eight feet, they will come to the bottom at the same time; as appears from experiments. And therefore the celestial regions being perfectly void of air and exhalations, the planets and comets meeting no sensible resistance in those spaces, will continue their motions through them for an immense space of time.

NIAGARA, a fort of North America taken from the French during the last war, which in a manner commands all the interior parts of the continent, and is a key to the whole of North America. It is situated on the lake Ontario; and about six leagues from it is the greatest cataract in the world, known by the name of the *water-fall of Niagara*. The river at this fall runs from S. S. E. to N. N. W. and the rock of the fall crosses it not in a right line, but forming a kind of figure like an hollow semicircle or horseshoe. Above the fall, in the middle of the river, is an island about 800 or 1000 feet long; the lower end of which is just at the perpendicular edge of the fall. On both sides of this island runs all the water that comes from the lakes of Canada; viz. Lake Superior, Lake Michigan, Lake Huron, and Lake Erie, which have some large rivers that open themselves into them. Before the water comes to this island, it runs but slowly compared with its motion afterwards, when it grows the most rapid in the world, running with a surprising swiftness before it comes to the fall. It is perfectly white, and in many places is thrown high up into the air. The water that runs down on the west side is more rapid, in greater abundance, and whiter, than that on the east side; and seems almost to outfly an arrow in swiftness. When you are at the fall, and look up the river, you may see that the water is every where exceedingly steep, almost like the side of an hill; but when you come to look at the fall itself, it is impossible to express the amazement it occasions. The height of it, as measured by mathematical instruments, is found to be exactly 137 feet; and when the water is come to the bottom, it jumps back to a very great height in the air. The noise may be heard at the distance of 45 miles, but seldom further; nor can it be heard even at Fort Niagara, which is only six leagues distant, unless Lake Ontario is calm. At that fort it is observed, that when they hear the noise of the fall more loud than ordinary, they are sure that a north-east wind will follow; which is the more sur-

prising, as the fort lies south-west from the fall. At some times the fall makes a much greater noise than at others; and this is held for an infallible sign of approaching rain or other bad weather.

From the place where the water falls there arises abundance of vapour like very thick smoke, inasmuch that when viewed at a distance you would think that the Indians had set the forests on fire. These vapours rise high in the air when it is calm, but are dispersed by the wind when it blows hard. If you go into this vapour or fog, or if the wind blows it on you, it is so penetrating, that a few moments you will be as wet as if you had been under water. Some are of opinion, that when birds come flying into this fog or smoke of the fall, they drop down and perish in the water; either because their wings are become wet, or that the noise of the fall astonishes them, and they know not where to go in the darkness: but others think that seldom or never any bird perishes there in that manner; because, among the abundance of birds found dead below the fall, there are no other sorts than such as live and swim frequently in the water; as swans, geese, ducks, water-hens, teal, and the like. And very often great flocks of them are seen going to destruction in this manner: they swim in the river above the fall, and so are carried down lower and lower by the water; and as water-fowl commonly take great delight in being carried with the stream, they indulge themselves in enjoying this pleasure so long, till the swiftness of the water becomes so great, that it is no longer possible for them to rise, but they are driven down the precipice, and perish. They are observed, when they draw nigh the fall, to endeavour with all their might to take wing and leave the water; but they cannot. In the months of September and October such abundant quantities of dead water-fowl are found every morning below the fall, on the shore, that the garrison of the fort for a long time live chiefly upon them. Besides the fowl, they find also several sorts of dead fish, also deer, bears, and other animals which have tried to cross the water above the fall; the larger animals are generally found broken to pieces. Just below, a little way from the fall, the water is not rapid, but goes all in circles, and whirls like a boiling pot; which however does not hinder the Indians going upon it in small canoes a-fishing; but a little further, and lower, the other smaller falls begin. When you are above the fall, and look down, your head begins to turn; even such as have been here numberless times, will seldom venture to look down, without at the same time keeping fast hold of some tree with one hand.

It was formerly thought impossible for any body living to come at the island that is in the middle of the fall: but an accident that happened 34 years ago, or thereabouts, made it appear otherwise. The history is this: Two Indians of the Six Nations went out from Niagara fort to hunt upon an island that is in the middle of the river, or strait, above the great fall, on which there used to be abundance of deer. They took some French Brandy with them from the fort, which they tasted several times as they were going over the carrying-place; and when they were in their canoe, they took now and then a dram, and so went along up the strait towards the island where they proposed

to hunt; but growing sleepy, they laid themselves down in the canoe, which getting loose drove back with the stream, farther and farther down, till it came nigh that island that is in the middle of the fall. Here one of them, awakened by the noise of the fall, cries out to the other, that they were gone: Yet they tried if possible to save life. This island was night, and with much working they got on shore their. At first they were glad; but when they had considered every thing, they thought themselves hardly in a better state than if they had gone down the fall, since they had now no other choice, than either to throw themselves down the fame, or perish with hunger. But hard necessity put them on invention. At the lower end of the island the rock is perpendicular, and no water is running there. The island has plenty of wood; they went to work then, and made a ladder or shrouds of the bark of the lind-tree (which is very tough and strong) so long till they could with it reach the water below; one end of this bark-ladder they tied fast to a great tree that grew at the side of the rock above the fall, and let the other end down to the water. So they went down along their new-invented stairs, and when they came to the bottom in the middle of the fall they rested a little; and as the water next below the fall is not rapid, as before-mentioned, they threw themselves out into it, thinking to swim on shore. We have said before, that one part of the fall is on one side of the island, the other on the other side. Hence it is, that the waters of the two cataracts running against each other, turn back against the rock that is just under the island. Therefore, hardly had the Indians begun to swim, before the waves of the eddy threw them down with violence against the rock from whence they came. They tired it several times, but at last grew weary; and by being often thrown against the rock they were much bruised, and the skin torn off their bodies in many places. So they were obliged to climb up stairs again to the island, not knowing what to do. After some time they perceived Indians on the shore, to whom they cried out. These saw and pitied them, but gave them little hope or help; yet they made haste down to the fort, and told the commandant where two of their brothers were. He persuaded them to try all possible means of relieving the two poor Indians; and it was done in the following manner.

The water that runs on the east side of this island is shallow, especially a little above the island towards the eastern shore. The commandant caused poles to be made and pointed with iron; two Indians took upon them to walk to this island by the help of these poles, to save the other poor creatures, or perish themselves. They took leave of all their friends, as if they were going to death. Each had two such poles in his hands, to set to the bottom of the stream, to keep them steady. So they went and got to the island, and having given poles to the two poor Indians there, they all returned safely to the main. These two Indians who in the above-mentioned manner were first brought to this island were nine days on the island, and almost ready to starve to death. Now since the road to this island has been found, the Indians go there often to kill deer, which have tried to cross the river above the fall, and are driven upon the island by the stream. the

Niagara  
Nicander.

the west side of this island are some small islands or rocks, of no consequence. The east side of the river is almost perpendicular, the west side more sloping. In former times a part of the rock at the fall which is on the west side of the island, hung over in such a manner, that the water which fell perpendicularly from it, left a vacancy below, so that people could go under between the rock and the water; but the prominent part some years since broke off and fell down. The breadth of the fall, as it runs in a semi-circle, is reckoned to be about 300 feet. The island is in the middle of the fall, and from it on each side is almost the same breadth; the breadth of the island at its lower end is about 100 feet. Below the fall, in the holes of the rocks, are great plenty of eels, which the Indians and French catch with their hands without any other means. Every day when the sun shines, you see here from ten o'clock in the morning to two in the afternoon, below the fall, and under you, where you stand at the side of the fall, a glorious rainbow, and sometimes two, one within the other. The more vapours, the brighter and clearer is the rainbow. When the wind carries the vapours from that place, the rainbow is gone, but appears again as soon as new vapours come. From the fall to the landing above it, where the canoes from Lake Erie put ashore (or from the fall to the upper end of the carrying-place) is half a mile. Lower the canoes dare not come, lest they should be obliged to try the fate of the two Indians, and perhaps with less success. They have often found below the fall pieces of human bodies, perhaps drunken Indians, that have unhappily come down to the fall. The French say, that they have often thrown whole great trees into the water above, to see them tumble down the fall: they went down with surprising swiftness, but could never be seen afterwards; whence it was thought there was a bottomless deep or abyss just under the fall. The rock of the fall consists of a grey limestone.

NICÆA, (anc. geogr.), the metropolis of Bithynia; situate on the lake Ancanius, in a large and fertile plain; in compass 16 stadia: first built by Antigonus, the son of Philip, and thence called *Antigonea*; afterwards completed by Lyfimachus, who called it *Nicæa*, after his consort the daughter of Antipater. According to Stephanus, it was originally a colony of the Bottiæi, a people of Thrace, and called *Acorea*; and afterwards called *Nicæa*. Now *Nice* in Asia the Less. Famous for the first general council.—A second *Nicæa*, (Diodorus Siculus), of Carthage.—A third, of the Hither India, (Arrian); situate on the west side of the Hydaspes, opposite to Bucphale, on the east side.—A fourth *Nicæa*, a town of Liguria, at the Maritime Alps, on the east side of the river Paulon near its mouth, which runs between the Varus and Nicæa, (Mela). A colony of the Massilians, (Stephanus); the last town of Italy to the west. Now *Nizza* or *Nice*, capital of the county of that name, on the Mediterranean.—A fifth, of Loeris, (Strabo); a town near Thermopylæ; one of the keys of that pass. It stood on the Sinus Malisæus.

NICANDER of Colophon, a celebrated grammarian, poet, and physician, who lived about the 160th Olympiad, 140 years before Christ, in the reign of

Attalus king of Pergamus, who overcame the Gallo-Greeks. He lived many years in Etolia, of which country he wrote a history. He wrote also many other works, of which only two are now remaining. The one is intitled *Theriacæ*, describing in verse the accidents attending wounds made by venomous beasts, with the proper remedies; the other bearing the title of *Alexipharmacæ*, wherein he treats poetically of poisons and their antidotes. This Nicaner is not to be confounded with Nicaner of Thyatira.

NICARAGUA, a large river of South America, in a province of the same name, whose western extremity lies within 5 miles of the South Sea. It is full of dreadful cataracts, and falls at length into the North Sea.

NICARAGUA, a maritime province of South America, in Mexico, bounded on the north by Honduras, on the east by the North Sea, on the south-east by Costa Rica, and on the south-west by the South Sea; being 400 miles in length from east to west, and 120 in breadth from north to south. It is one of the most fruitful and agreeable provinces in Mexico, and is well watered with lakes and rivers. The air is wholesome and temperate; and this country produces plenty of sugar, cochineal, and fine chocolate. One of the lakes is 200 miles in circumference, has an island in the middle, and, as some say, has a tide. Leon de Nicaragua is the capital town.

NICARIA, an island of the Archipelago, between Samos and Tine, about 50 miles in circumference. A chain of high mountains run thro' the middle, covered with wood, and supply the country with springs. The inhabitants are very poor, and of the Greek communion; however, they have a little wheat, and a good deal of barley, figs, honey, and wax.

NICASTRO, an episcopal town of Italy, in the kingdom of Naples, and in the Farther Calabria; 16 miles south of Cosenza. E. Long. 15. 59. N. Lat. 39. 15.

NICE, an ancient, handsome, and considerable town on the confines of France and Italy, and capital of a county of the same name, with a strong citadel, a bishop's see, and a senate, which is a kind of a democracy. It has been several times taken by the French, and last of all in 1744, but rendered back after the treaty of Aix-la-Chapelle. It is very agreeably situated, four miles from the mouth of the river Var, 83 miles S. by W. of Turin, and 83 east of Aix. E. Long. 6. 22. N. Lat. 43. 42.

NICE, a county and province in the dominions of the duke of Savoy, bounded on the east by the territory of Genoa and Proper Piedmont, on the north by the marquise of Saluces and Dauphiny, on the west by Provence and the Mediterranean sea, and on the south by the principality of Monaco. The inhabitants supply Genoa with a great deal of timber for building ships; and carry on a great trade in lincloth, paper, oil, wine, and honey. Nice is the capital town.

NICE, an ancient town of Asia, in Natolia, now called *Isnick*, with a Greek archbishop's see. It is famous for the general council assembled here in 325, who endeavoured to suppress the doctrines of Arius. It was formerly a large, populous, and well-built place, and now is not inconsiderable. See ISNIC.

Nicaragua  
Nicc.

Nicephorus  
Nictetas.

**NICEPHORUS** (Gregorius), a Greek historian in the 14th century, was librarian to the church of Constantinople, and had a great share in the transactions of his time. He wrote a history, which extends from the year 1204 to 1341. The best edition of this work is that of the Louvre, in Greek and Latin, in 1702.

**NICEPHORUS** (Calistus), a Greek historian, who flourished in the 14th century under the emperor Andronicus Paleologus the elder, wrote an ecclesiastical history in 23 books; 18 of which are still extant, containing the transactions of the church from the birth of Christ to the death of the emperor Phocas in 610. We have nothing else but the arguments of the other five books from the commencement of the reign of the emperor Heraclius to the end of that of Leo the philosopher, who died in the year 911. Nicephorus dedicated his history to Andronicus Paleologus the Elder. It was translated into Latin by John Langius; and has gone through several editions, the best of which is that of Paris in 1630.

**NICERON** (John Francis), an ingenious min-  
nim, born at Paris in 1613, who distinguished himself by his knowledge in Optics, concerning which he wrote some treatises, though he died at the age of 33.

**NICERON** (John Peter), was born at Paris, of an ancient and noble family, in the year 1685. He entered young into the order of Barnabites, and was professor of rhetoric and philosophy in the college of Montargis. He is sufficiently known for conducting the "Memoirs of men illustrious in the republic of letters," of which he published 39 volumes. He also translated some English works into French.

**NICETAS** (David), a Greek historian, a native, as some relate, of Paphlagonia, who lived about the end of the 9th century. He wrote, The life of St Ignatius, patriarch of Constantinople; which was translated into Latin by Frederic Mutius bishop of Termoli: he composed also several panegyrics in honour of the apostles and other saints, which are inserted in the last continuation of the *Bibliotheca Patrum* by Combefis.

**NICETAS** (surnamed **SERRON**), deacon of the church of Constantinople, cotemporary with Theophylact in the 11th century, and afterwards bishop of Heraclaea, wrote a *Catena* upon the book of Job, compiled from passages of several of the fathers, which was printed at London in folio, 1637. We have also, by the same writer, several *catena* upon the Psalms and Canticles, Basil 1552; together with a Commentary on the poems of Gregory Nazianzen.

**NICETAS** (Arbominatis), a Greek historian of the 13th century, called *Comitates*, as being born at Chone, or Colossus, in Phrygia. He was employed in several considerable affairs at the court of Constantinople; and when that city was taken by the French in 1204, he withdrew with a young girl taken from the enemy, to Nice in Bithynia, where he married his captive, and died in 1206. He wrote a History, or Annals, from the death of Alexius Comnenus in the year 1118, to that of Badouin in 1205: of which work we have a Latin translation by Jerome Wolfius, printed at Basil in 1557; and it has been inserted in the body of the Byzantine Historians, printed in France at the

Louvre.

**NICHE**, in architecture, a hollow sunk into a wall, for the commodious and agreeable placing of a statue. The word comes from the Italian *nicchia*, "sea-shell;" in regard the statue is here inclosed in a shell, or perhaps on account of the shell wherewith the tops of some of them are adorned.

**NICIAS**, a celebrated painter of Athens, flourished about 322 years before the Christian era; and was universally extolled for the great variety and noble choice of his subjects, the force and reliev of his figures, his skill in the distribution of the lights and shadows, and his dexterity in representing all sorts of four-footed animals, beyond any master of his time. His most celebrated piece was that of Tartarus or Hell, as it is described by Homer, for which king Ptolemy the son of Lagus offered him 60 talents, or 11,250*l.* which he refused, and generously presented it to his own country. He was likewise much esteemed by all his cotemporaries, for his excellent talent in sculpture.

**NICKEL**, a semi-metal, first described by Mr Cronstedt in the Swedish Memoirs for the years 1751 and 1754. The properties there attributed to it are, 1. That it is of a white colour, inclining to red. 2. Its texture is solid, and shining in its fractures. 3. Its specific gravity is to that of water as 8500 to 1000. 4. It is considerably fixed in the fire. 5. It is calcinable, and its calx is green. 6. This calx is not very fusible; but it nevertheless tinges glass of a transparent reddish brown, or jacinth colour. 7. It dissolves in aquafortis, aqua regia, and marine acid, but difficultly in vitriolic acid. All these solutions have a deep-green colour. The vitriol formed of it is also of the same colour; and the colcothar of this vitriol, and also the precipitates from the solutions, are rendered by calcination of a light-green colour. 8. These precipitates are soluble by spirit of sal ammoniac, and the solution has a blue colour. But no copper can be produced by a reduction of the precipitates. 9. It strongly attracts sulphur. 10. It unites with all metallic substances, excepting silver, quicksilver, and zinc. Its attraction to regulus of cobalt is the strongest, next to which is that to iron, and then to arsenic. 11. It retains its phlogiston a long time in the fire, and its calx is reducible by a very small quantity of inflammable matter. It requires, however, a strong red heat before it can be fused, and melts a little sooner, or as soon as gold or copper. Nickel is contained in the reddish-yellow mineral, called *Kupfer-nickel*, which, besides nickel, contains also iron, regulus of cobalt, arsenic, and sulphur.

**NICOBAR ISLANDS**, the name of several islands in Asia, lying at the entrance of the gulph of Bengal. The largest of these islands is about 40 miles long and 15 broad, and the inhabitants are said to be a harmless sort of people, ready to supply the ships that stop there with provisions.

**NICOLAITANS**, in church-history, Christian heretics who assumed this name from Nicholas of Antioch; who, being a Gentile by birth, first embraced Judaism, and then Christianity; when his zeal and devotion recommended him to the church of Jerusalem, by whom he was chosen one of the first deacons. Many of the primitive writers believe that Nicholas

Niche  
Nicolaitans.



Nicolas  
Nicolopi.

cholas was rather the occasion than the author of the infamous practices of those who assumed his name, who were expressly condemned by the Spirit of God himself, Rev. ii. 6. And indeed their opinions and actions were highly extravagant and criminal. They allowed a community of wives, and made no distinction between ordinary meats and those offered to idols. According to Eusebius, they substituted but a short time; but Tertullian says that they only changed their name, and that their heresies passed into the sect of the Cainians.

NICOLAS (St), an island of the Atlantic Ocean, and one of the most considerable of those of Cape Verde, lying between Santa Lucia and St Jago. It is of a triangular figure, and about 75 miles in length. The land is stony, mountainous, and barren; but there are a great many goats in a valley inhabited by the Portuguese. W. Long. 33. 35. N. Lat. 17. 0.

NICOLE (Peter), one of the finest writers in Europe, was born at Chartres in 1625, of a conspicuous family. He adhered to the Jansemits; and joined in the composition of several works with Mr Arnauld, whose faithful companion he was during the 10 or 12 years of his retirement. He gave a Latin translation of Pascal's *Provinciales*, and added a commentary to them. One of his finest works is his *Essais de Morale*. He wrote very subtly against the Protestants. His treatise on the unity of the church is esteemed a masterly piece. He died at Paris in 1695, a few days after the publication of his treatise concerning the Quietists. He was greatly skilled in polite literature. To him is ascribed a collection of Latin epigrams, and of Greek, Spanish, and Italian sentences, which has borne several impressions, and has a learned preface to it.

NICOLO (St), the most considerable, strongest, and best peopled of the isles of Tremiti in the gulf of Venice, to the east of St Domino, and to the south of Capparata. It has a harbour defended by several towers; and a fortress, in which is an abbey, with a very handsome church. E. Long. 15. 37. N. Lat. 42. 7.

NICOMEDES, the name of several kings of the ancient Bithynia. See ΒΙΤΗΝΙΑ.

NICOMEDIA (anc. geogr.), metropolis of Bithynia, built by Nicomedes the grandfather of Prusias. Situated on a point of the Sinus Astacenus, (Pliny); surnamed the *Beautiful*, (Athenæus): the largest city of Bithynia, (Paulsanias), who says it was formerly called *Astacus*; though Pliny distinguishes Astacum and Nicomedia as different cities. Nicomedia was very famous, not only under its own kings, but under the Romans: the royal residence of Dioclesian, and of Constantine while Constantinople was building, if we may credit Nicephorus. It is still called *Nicomedia*, at the bottom of a bay of the Propontis in the Hither Asia. E. Long. 30. 0. N. Lat. 41. 20. It is a place of consequence; carries on a trade in silk, cotton, glass, and earthen-ware, and is the see of a Greek archbishop.

NICOPOLI, a town of Turkey in Europe, and in Bulgaria, famous for being the place where the first battle was fought between the Turks and Christians in 1396; and where the latter were defeated with

the loss of 20,000 men. E. Long. 25. 33. N. Lat. 43. 46.

NICOSIA, the capital of the island of Cyprus, where a Turkish bashaw resides. It is delightfully situated between the mountains of Olympus, and a chain of others; and was formerly well fortified by the Venetians; but the works are now in ruins. E. Long. 33. 35. N. Lat. 35. 1.

NICOT (John), lord of Vilemain, and master of requests of the French king's household, was born at Nîmes, and was sent ambassador to Portugal in 1559; whence he brought the plant which, from his name, was called *Nicotiana*, but is now more known by the name of *tobacco*. He died at Paris in 1603. He wrote a French and Latin dictionary in folio; a treatise on navigation; and other works.

NICOTTIANA, TOBACCO; a genus of the monogynia order, belonging to the pentandria class of plants. There are seven species, of which the most remarkable is the tabacum, or common tobacco-plant. This was first discovered in America by the Spaniards about the year 1560, and by them imported into Europe. It had been used by the inhabitants of America long before; and was called by those of the islands *yoli*, and *petun* by the inhabitants of the continent. It was sent into Spain from Tabaco, a province of Yucatan, where it was first discovered, and from whence it takes its common name. Sir Walter Raleigh first introduced it into England about the year 1585, and was the first who taught them how to smoke it. Tobacco is commonly used among the oriental nations, though it is uncertain by whom it was introduced among them. Considerable quantities of it are cultivated in the Levant, on the coasts of Greece and the Archipelago, in Italy, and in the island of Malta.

There are two varieties of that species of *Nicotiana* which is cultivated for common use, and which are distinguished by the names of *Oronokee*, and *sweet-scented tobacco*. They differ from each other only in the figure of their leaves; those of the former being longer and narrower than the latter. They are tall herbaceous plants, growing erect with fine foliage, and rising with a strong stem from six to nine feet high. The stalk, near the root, is upwards of an inch diameter, and surrounded with a kind of hairy or velvet clammy substance, of a yellowish-green colour. The leaves are rather of a deeper green, and grow alternately at the distance of two or three inches from each other. They are oblong, of a spear-shaped oval, and simple; the largest about 20 inches long, but decreasing in size as they ascend, till they come to be only 10 inches long, and about half as broad. The face of the leaves is much corrugated, like those of spinach when full ripe. Before they come to maturity, when they are about five or six inches long, the leaves are generally of a full green, and rather smooth; but as they increase in size, they become rougher, and acquire a yellowish cast. The stem and branches are terminated by large bunches of flowers collected into clusters, of a delicate red; the edges, when full-blown, inclining to a pale purple. They continue in succession till the end of the summer; when they are succeeded by seeds of a brown colour, and kidney-shaped. These are very small, each capsule containing about 1000; and the

Nicofia  
Nicotiana.

Nicotiana. the whole produce of a single plant is reckoned at about 350,000. The seeds ripen in the month of September.

Mr Carver informs us, that the Oronokoe, or, as it is called, the *long Virginia tobacco*, is the kind best suited for bearing the rigour of a northern climate, the strength as well as the scent of the leaves being greater than that of the other. The *sweet-scented* sort flourishes most in a sandy soil, and in a warm climate, where it greatly exceeds the former in the celerity of its growth; and is likewise, as its name intimates, much more mild and pleasant.

Tobacco thrives best in a warm, kindly, rich soil, that is not subject to be over-run by weeds. In Virginia, the soil in which it thrives best is warm, light, and inclining to be sandy; and therefore, if the plant is to be cultivated in Britain, it ought to be planted in a soil as nearly of the same kind as possible. Other kinds of soils might probably be brought to suit it, by a mixture of proper manure; but we must remember, that whatever manure is made use of must be thoroughly incorporated with the soil. The best situation for a tobacco plantation is the southern declivity of a hill rather gradual than abrupt, or a spot that is sheltered from the north winds: but at the same time it is necessary that the plants enjoy a free air; for without that they will not prosper.

As tobacco is an annual plant, those who intend to cultivate it ought to be as careful as possible in the choice of the seeds; in which, however, with all their care, they may be sometimes deceived. The seeds are to be sown about the middle of April, or rather sooner in a forward season, in a bed prepared for this purpose of such soil as hath been already described, mixed with some warm rich manure. In a cold spring, hot-beds are most eligible for this purpose, and gardeners imagine that they are always necessary: but Mr Carver tells us, that he is convinced, when the weather is not very severe, the tobacco-seeds may be raised without doors; and for this purpose gives us the following directions.

“ Having sown the seed in the manner above directed, on the least apprehension of a frost after the plants appear, it will be necessary to spread mats over the beds, a little elevated from the ground by poles laid across, that they may not be crushed. These, however, must be removed in the morning soon after the sun appears, that they may receive as much benefit as possible from its warmth, and from the air. In this manner proceed till the leaves have attained about two inches in length, and one in breadth; which they will do in about a month after they are sown, or near the middle of May, when the frosts are usually at an end. One invariable rule for their being able to bear removal is, when the fourth leaf is sprouted, and the fifth just appears. Then take the opportunity of the first rains or gentle showers to transplant them into such a soil and situation as before described; which must be done in the following manner.—The land must be ploughed, or dug up with spades, and made as mellow and light as possible. Where the plants are to be placed, raise with the hoe small hillocks at the distance of two feet or a little more from each other, taking care that no hard fods or lumps are in it; and then jolt indent the middle of each, without drilling

holes, as for some other plants.

“ When your ground is thus prepared, dig in a gentle manner from their native bed such plants as have attained the proper growth for transplanting above-mentioned; and drop, as you pass, one on every hillock. Inset a plant gently into each centre, pressing the soil around it gently with your fingers; and taking the greatest care, during the operation, that you do not break off any of the leaves, which are at this time exquisitely tender. If the weather proves dry after they are thus transplanted, they must be watered with soft water, in the same manner as is usually done to coleworts, or plants of a similar kind. But though you now seem to have a sufficient quantity of plants for the space you intend to cultivate, it is yet necessary that you continue to attend to your bed of seedlings, that you may have enough to supply any deficiencies which through accident may arise. From this time great care must be taken to keep the ground soft and free from weeds, by often stirring with your hoe the mould round the roots; and to prune off the dead leaves that sometimes are found near the bottom of the stalk.

“ The difference of this climate from that in which I have been accustomed to observe the progress of this plant, will not permit me to direct with certainty the time which is most proper to take off the top of it, to prevent it from running to seed. This knowledge can only be acquired by experience. When it has risen to the height of more than two feet, it commonly begins to put forth the branches on which the flowers and seeds are produced; but as this expansion, if suffered to take place, would drain the nutriment from the leaves, which are the most valuable part, and thereby lessen their size and efficacy, it becomes needful at this stage to nip off the extremity of the stalk to prevent its growing higher. In some other climates, the top is commonly cut off when the plant has 15 leaves; but if the tobacco is intended to be a little stronger than usual, this is done when it has only 13; and sometimes, when it is designed to be remarkably powerful, 11 or 12 are only allowed to expand. On the contrary, if the planter is desirous of having his crop very mild, he suffers it to put forth 18 or 20: but in this calculation, the three or four lower leaves next the ground, which do not grow so large and fine as the others, are not to be reckoned.

“ This operation, denominated *topping* the tobacco, is much better performed by the finger and thumb than with any instrument; because the grasp of the fingers closes the pores of the plant; whereas, when it is done by instruments, the juices are in some degree exhausted. Care must also be taken to nip off the sprouts that will be continually springing up at the junction of the leaves with the stalks. This is termed *succouring*, or *sucker*ing, the tobacco; and ought to be repeated as often as occasion requires.

“ As it is impossible to ascertain the due time for topping the plant, so it is equally impossible, without experiment, to ascertain the time it will take to ripen in this country. The apparent signs of its maturity are these: The leaves, as they approach a state of ripeness, become more corrugated or rough; and when fully ripe, appear mottled with yellowish spots on the raised parts; whilst the cavities retain their usual green colour.

They

Nicotiana. They are at this time also thicker than they have before been; and are covered with a downy velvet, like that formerly mentioned, on the stalks. If heavy rains happen at this critical period, they will wash off this excrecent substance, and thereby damage the plants. In this case, if the frothy nights are not begun, it is proper to let them stand a few days longer; when, if the weather be moderate, they will recover this substance again. But if a frost unexpectedly happens during the night, they must be carefully examined in the morning, before the sun has any influence upon them; and those which are found to be covered with frothy particles, whether thoroughly ripe or not, must be cut up; for though they may not all appear to be arrived at a state of maturity, yet they cannot be far from it, and will differ but little in goodness from those that are perfectly so."

Tobacco is subject to be destroyed by a worm; and without proper care to exterminate this enemy, a whole field of plants may soon be lost. This animal is of the horned species, and appears to be peculiar to the tobacco-plant; so that in many parts of America it is distinguished by the name of the *tobacco-worm*. In what manner it is first produced, or how propagated, is unknown: but it is not discernible till the plants have attained about half their height; and then appears to be nearly as large as a gnat. Soon after this it lengthens into a worm; and by degrees increases in magnitude to the bigness of a man's finger. In shape it is regular from its head to its tail, without any diminution at either extremity. It is indented or ribbed round at equal distances, nearly a quarter of an inch from each other; and having at every one of these divisions a pair of feet or claws, by which it fastens itself to the plant. Its mouth, like that of the caterpillar, is placed under the fore-part of the head. On the top of the head, between the eyes, grows a horn about half an inch long, and greatly resembling a thorn; the extreme part of which is of a brown colour, a firm texture, and the extremity sharp-pointed. It is easily crushed; being only, to appearance, a collection of green juice inclosed in a membranaceous covering, without the internal parts of an animated being. The colour of its skin is in general green, interspersed with several spots of a yellowish white; and the whole covered with a short hair scarcely to be discerned. These worms are found the most predominant during the latter end of July and the beginning of August; at which time the plants must be particularly attended to, and every leaf carefully searched. As soon as a wound is discovered, and it will not be long before it is perceptible, care must be taken to destroy the cause of it, who will be found near it, and from his unsubstantial texture may easily be crushed: but the best method is to pull it away by the horn, and then crush it.

When the tobacco is fit for being gathered, as will appear from an attention to the foregoing directions, on the first morning that promises a fair day, before the sun is risen, take an ax or a long knife, and holding the stalk near the top with one hand, sever it from its root with the other, as low as possible. Lay it gently on the ground, taking care not to break off the leaves, and there let it remain exposed to the rays of the sun throughout the day, or until the leaves, according to the American expression, are entirely *wilted*;

that is, till they become limber, and will bend any way without breaking. But if the weather should prove rainy without any intervals of sunshine, and the plants appear to be fully ripe, they must be hoisted immediately. This must be done, however, with great care, that the leaves, which are in this state very brittle, may not be broken. They are next to be placed under proper shelter, either in a barn or covered hovel, where they cannot be affected by rain or too much air, thinly scattered on the floor; and if the sun does not appear for several days, they must be left to wither in that manner; but in this case the quantity of the tobacco will not be quite so good.

When the leaves have acquired the above-mentioned flexibility, the plants must be laid in heaps, or rather in one heap if the quantity is not too great, and in about 24 hours they will be found to sweat. But during this time, when they have lain for a little while, and begin to foment, it will be necessary to turn them; bringing those which are in the middle to the surface, and placing those which are at the surface in the middle. The longer they lie in this situation, the darker-coloured is the tobacco; and this is termed *sweating* the tobacco. After they have lain in this manner for three or four days, for a longer continuance might make the plants turn mouldy, they may be fastened together in pairs with chords or wooden pegs, near the bottom of the stalk, and hung across a pole, with the leaves suspended in the same covered place, a proper interval being left between each pair. In about a month the leaves will be thoroughly dried, and of a proper temperature to be taken down. This state may be ascertained by their appearing of the same colour with those imported from America. But this can be done only in wet weather.—The tobacco is exceedingly apt to attract the humidity of the atmosphere, which gives it a pliability that is absolutely necessary for its preservation; for if the plants are removed in a very dry season, the external parts of the leaves will crumble into dust, and a considerable waste will ensue.

As soon as the plants are taken down, they must again be laid in a heap, and pressed with heavy logs of wood for about a week; but this climate may possibly require a longer time. While they remain in this state, it will be necessary to introduce your hand frequently into the heap, to discover whether the heat be not too intense; for in large quantities this will sometimes be the case, and considerable damage will be occasioned by it. When they are found to heat too much, that is, when the heat exceeds a moderate glowing warmth, part of the weight by which they are pressed must be taken away; and the cause being removed, the effect will cease. This is called the *second* or *last sweating*; and, when completed, which it generally will be about the time just mentioned, the leaves may be stripped from the stalks for use. Many omit this last sweating; but Mr Carver thinks that it takes away any remaining harshness, and renders the tobacco more mellow. The strength of the stalk also is diffused by it through the leaves, and the whole mass becomes equally meliorated.—When the leaves are stripped from the stalks, they are to be tied up in bunches or *hands*, and kept in a cellar or other damp place; though if not handled in dry weather,

Nicotiana.

weather, but only during a rainy season, it is of little consequence in what part of the house or barn they are laid up. At this period the tobacco is thoroughly cured, and as proper for manufacturing with that imported from the colonies.

Our author advises the tobacco-planter, in his first trials, not to be too avaricious, but to top his plants before they have gained their utmost height; leaving only about the middle quantity of leaves directed before, to give it a tolerable degree of strength. For tho' this, if excessive, might be abated during the cure by an increase of sweating, or be remedied the next season by suffering more leaves to grow, it can never be added, and, without a certain degree of strength, the tobacco will always be tasteless, and of little value. On the contrary, though it be ever so much weakened by sweating, and thereby rendered mild, yet it will never lose the aromatic flavour which accompanied that strength, and which greatly adds to its value. A square yard of land, he tells us, will rear about 500 plants, and allow proper space for their nurture till they are fit for transplanting.

Tobacco has sometimes been prescribed internally; in which case it proves violently cathartic and emetic, occasioning almost intolerable cardiacal anxieties. By boiling in water its virulence is abated, and at length destroyed. An extract made by long coction is recommended by Stahl and other German physicians, as a safe and most effectual aperient, expectorant, detergent, &c. but this medicine, which, according to Dr Lewis, is extremely precarious and uncertain in strength, has never come into esteem in this country. Tobacco is sometimes used externally in unguents for destroying cutaneous insects, cleaning old ulcers, &c. Beaten into a mash with vinegar or brandy, it has sometimes proved serviceable for removing hard tumours of the hypochondres: an account is given in the Edinburgh Essays of two cases of this kind cured by it. The most common uses of this plant, however, are, either as a stimulatory when taken by way of snuff, as a masticatory by chewing it in the mouth, or as effluvia by smoking it; and when taken in moderation, it is not an unhealthy amusement. Before pipes were invented, it was usually smoked in segars, and they are still in use among some of the southern nations. The method of preparing these is at once simple and expeditious: A leaf of tobacco being formed into a small twisted roll, somewhat larger than the stem of a pipe, and about eight inches long, the smoke is conveyed through the winding folds which prevent it from expanding, as through a tube; so that one end of it being lighted, and the other applied to the mouth, it is in this form used without much inconvenience. But, in process of time, pipes being invented, they were found more commodious vehicles for the smoke, and are now in general use.

Among all the productions of foreign climes introduced into these kingdoms, scarce any has been held in higher estimation by persons of every rank than tobacco. In the countries of which it is a native, it is considered by the Indians as the most valuable offering that can be made to the beings they worship. They use it in all their civil and religious ceremonies. When once the spiral wreaths of its smoke ascend from the feathered pipe of peace, the compact that has been

just made is considered as sacred and inviolable. Likewise, when they address their great Father, or his guardian spirits, residing as they believe in every extraordinary production of nature, they make liberal offerings to them of this valuable plant, not doubting but that they are thus secured of protection.

Tobacco is made up into rolls by the inhabitants of the interior parts of America by means of a machine called a *tobacco-wheel*. With this machine they spin the leaves, after they are cured, into a twist of any size they think fit; and having folded it into rolls of about 20 pounds each, they lay it by for use. In this state it will keep for several years, and be continually improving, as it always grows milder. The Illinois usually form it into carrots; which is done by laying a number of leaves, when cured, on each other, after the ribs have been taken out, and rolling them round with pack-thread till they become cemented together. These rolls commonly measure about 18 or 20 inches long, and nine round in the middle part.

Tobacco forms a very considerable article in commerce; for an account of which see the articles GLAZGOW and VIRGINIA.

NICTITATING MEMBRANE, a thin membrane chiefly found in the bird and fish kind, which covers the eyes of these animals, sheltering them from the dust or too much light; yet is so thin and pellucid, that they can see pretty well through it.

NIDUS, among naturalists, signifies a nest, or proper repository for the eggs of birds, insects, &c. where the young of these animals are hatched and nursed.

NIDIFICATION, a term generally applied to the formation of a bird's nest, and its hatching or bringing forth its young. See ORNITHOLOGY.

NIECE, a brother's or sister's daughter, which in the civil law is reckoned the third degree of consanguinity.

NIEMEN, a large river of Poland, which rises in Lithuania, where it passes by Bielica, Grodno, and Konno: it afterwards runs thro' part of Samogitia and Ducal Prussia, where it falls into the lake called the *Curisch-bass*, by several mouths, of which the most northern is called the *Rusi*, being the name of a town it passes by.

NIENBURG, a rich and strong town of Germany, in the duchy of Brunswic-Lunenburg, with a strong castle. It carries on a considerable trade in corn and wool, and is seated in a fertile soil on the river Weser. E. Long. 9. 26. N. lat. 52. 44.

NIEPER, a large river of Europe, and one of the most considerable of the North, formerly called the Boristhenes. Its source is in the middle of Muscovy, running west by Smolensko, as far as Orsa; and then turns south, passing by Mohilow, Bohaczow, Kiow, Czyrkassky, the fortrefs of Kudak, Dessau, and Oczakow, falling into the Black Sea; as also in its course it divides Little Tartary from Budziac Tartary.

NIESTER, a large river of Poland, which has its source in the Lake Neider, in the palatinate of Lemburg, where it passes by Halicz. Then it separates Podolia and Oczakow Tartary from Moldavia and Budziac Tartary; and falls into the Black Sea at Belgorod, between the mouths of the Nieper and the Danube.

Nicotiana  
Niesler.

Nieuwentyt NIEUWENTYT (Bernard), an able philosopher and learned mathematician, was born at Weelgraafdyk, in the year 1654, and became counsellor and burgo-master of the town of Purmerend, where he was esteemed for his integrity and learning, and died in 1718. He wrote, in Dutch, 1. An excellent treatise, intitled, The Existence of God demonstrated by the works of nature. 2. A refutation of Spinoza. 3. Some pieces against the Infinitesimals, &c.

NIGELLA, FENNEL-FLOWER, or *Devil in a bush*; a genus of the pentagynia order, belonging to the polyandria class of plants. There are five species, all of them natives of the warm parts of Europe, and rising from a foot to a foot and an half high, adorned with blue or yellow flowers. They are propagated by seeds, which in a dry and warm situation will thrive very well; and the plants ripen seeds in this country.

NIGER, a great river of Africa, supposed to have its origin near that of the Nile; but this is very uncertain. We are assured, however, that it is a river of very great extent; especially if we suppose, according to the opinion of the best modern geographers, that it has its source in the kingdom of Gorian, not far from the confines of Upper Ethiopia; for then it will cross almost the whole continent of Africa, where it is widest. In its course it receives many considerable rivers, which swell it high enough to be able at all times to carry vessels of good burden; so it splits itself into several branches, which uniting again form very large and fertile islands, well filled with towns and villages. It passes also through several lakes, and has many cataracts. After having run from east to west, during a prodigious long course, it turns at last short to the south, at a league and a half distance from the western ocean; leaving but a very narrow tract between it and the sea, into which it opens its way in lat. 15. 55. after having run about 25 leagues from north to south. Its mouth is sometimes half a league broad; but is shut up by a bank of quick-sand called the *bar of Senegal*, where the water is so shallow, that it is very difficult and dangerous to pass over it. The bar is formed by the mud and sand which the river brings with it during the inundation, and which the sea continually drives back upon the shore. This would effectually exclude all shipping, had not the violence of the current, and the weight of the waters, made two openings or channels, which are commonly called the *passes of the bar*. The largest of these is generally not above 150 or 200 fathoms broad, and about 10 feet deep, so that none but barks of 40 or 50 tons can get through this channel; the other is so narrow and shallow, that it is passable by canoes only. These channels are not always in the same place; for the river, as it is more or less swelled, or the current more or less rapid, opens those passes sometimes in one place, and sometimes in another. The bar itself also frequently shifts its place; so that the island of Senegal is sometimes four leagues distant from it, at other times only two. It is this bar only which hinders ships of 400 or 500 tons to go up the river.

NIGHT, that part of the natural day during which the sun is underneath the horizon; or that space wherein it is dark.

Night was originally divided by the Hebrews and other eastern nations into three parts or watches.

The Romans, and after them the Jews, divided the night into four parts or watches; the first of which began at sunset, and lasted till nine at night, according to our way of reckoning; the second lasted till midnight; the third till three in the morning; and the fourth ended at sunrise. The ancient Gauls and Germans divided their time not by days but nights; and the people of Iceland and the Arabs do the same at this day. The like is observed of the Anglo-Saxons.

NIGHT-*Angling*, a method of catching large and shy fish in the night-time. Trout, and many other of the better sorts of fish, are naturally shy and fearful; they therefore prey in the night as the securest time.—The method of taking them on this plan is as follows. The tackle must be strong, and need not be so fine as for day-fishing, when every thing is seen; the hook must be baited with a large earth-worm, or a black snail, and thrown out into the river; there must be no lead to the line, so that the bait may not sink, but be kept drawing along, upon or near the surface. Whatever trout is near the place will be brought thither by the motion of the water, and will seize the worm or snail. The angler will be alarmed by the noise which the fish makes in rising, and is to give him line, and time to swallow the hook; then a slight touch secures him. The best and largest trouts are found to bite thus in the night; and they rise mostly in the still and clear deeps, not in the swift and shallow currents. Sometimes, though there are fish about the place, they will not rise at the bait; in this case the angler must put on some lead to his line, and sink it to the bottom.

NIGHT-*Mare*, or *Incubus*. See MEDICINE, n° 430.

NIGHT-*Walkers*, in medicine. See NOCTAMBULI.

NIGHT-*Walkers*, in law, are such persons as sleep by *Blockf. Comment.* day and walk by night, being oftentimes pilferers or disturbers of the public peace. Constables are authorized by the common law to arrest night-walkers and suspicious persons, &c. Watchmen may also arrest night-walkers, and hold them until the morning: and it is said, that a private person may arrest any suspicious night-walker, and detain him till he give a good account of himself. One may be bound to the good behaviour for being a night-walker; and common night-walkers, or haunters of bawdy-houses, are to be indicted before justices of peace, &c. But it is not held lawful for a constable, &c. to take up any woman as a night-walker on bare suspicion only of being of ill fame, unless she be guilty of a breach of the peace, or some unlawful act, and ought to be found misdoing.

NIGHTINGALE, in ornithology; a species of MOTACILLA; under which article it happened to be omitted.

The nightingale takes its name from *night*, and the Saxon word *galan*, “to sing;” expressive of the time of its melody. In size it is equal to the redstart; but longer-bodied, and more elegantly made. The colours are very plain. The head and back are of a pale tawny, dashed with olive: the tail is of a deep tawny red: the throat, breast, and upper part of the belly, of a light glossy ash-colour: the lower belly almost white: the exterior webs of the quill-feathers are of a dull reddish brown; the interior of brownish ash-colour: the irides are hazel, and the eyes remarkably large

Nightingale. large and piercing: the legs and feet a deep ash-colour.

To the night-warbling bird, that now awake  
Tunes sweetest his love-labour'd song.

Nightingale  
||  
Nile.

This bird, the most famed of the feathered tribe, for the variety, length, and sweetness of its notes, visits England the beginning of April, and leaves us in August. It is a species that does not spread itself over the island. It is not found in North Wales; or in any of the English counties north of it, except Yorkshire, where they are met with in great plenty about Doncaster. They have been also heard, but rarely, near Shrewsbury. It is also remarkable, that this bird does not migrate so far west as Devonshire and Cornwall; counties where the seasons are so very mild, that myrtles flourish in the open air during the whole year: neither are they found in Ireland. Sibbald places them in his list of Scotch birds; but they certainly are unknown in that part of Great Britain, probably from the scarcity and the recent introduction of hedges there. Yet they visit Sweden, a much more severe climate. In England they frequent thick hedges, and low coppices; and generally keep in the middle of the bush, so that they are very rarely seen. They form their nest of oak leaves, a few bents and reeds. The eggs are of a deep brown. When the young ones first come abroad, and are helpless, the old birds make a plaintive and jarring noise with a sort of snapping as if in menace, pursuing along the hedge the passengers.

They begin their song in the evening, and continue it the whole night. These their vigils did not pass unnoticed by the ancients: the flumbers of these birds were proverbial; and not to rest as much as the nightingale, expressed a very bad sleeper (A). This was the favourite bird of the British poet, who omits no opportunity of introducing it, and almost constantly noting its love of solitude and night. How finely does it serve to compose part of the solema scenery of his *Penferoso*; when he describes it

In her saddest sweetest plight,  
Smoothing the rugged brow of night;  
While *Cynthia* cheeks her dragon yoke,  
Gently o'er th' acustom'd oak.  
Sweet bird, that shunn'st the noise of folly,  
Most musical, most melancholy!  
Thee, chauntress, oft the woods among,  
I woo to hear thy evening song.

In another place he styles it the *solemn bird*; and again speaks of it,

As the wakeful bird  
Sings darkling, and, in shades covert hid,  
'Tunes her nocturnal note.

The reader will excuse a few more quotations from the same poet, on the same subject; the first describes the approach of evening, and the retiring of all animals to their repose.

Silence accompanied; for beast and bird,  
They to their grassy couch, these to their nests  
Were flunk: all but the wakeful nightingale,  
She all night long her amorous descant sung.

When Eve pass'd the irksome night preceding her fall, she, in a dream, imagines herself thus reproached with losing the beauties of the night by indulging too long a repose.

Why sleep'st thou, *Eve*? now is the pleasant time,  
The cool, the silent, save where silence yields

(A) *Ælian var. hist.* 577. both in the text and note. It must be remarked, that nightingales sing also in the day.

The same birds sing their nuptial song, and lull them to rest. How rapturous are the following lines! how expressive of the delicate sensibility of our Milton's tender ideas!

The earth  
Gave sign of gratulation, and each hill;  
Joyous the birds; fresh gales and gentle airs  
Whisper'd it to the woods, and from their wings  
Flung rose, flung odours from the spicy shrub,  
Disporting, till the amorous bird of night  
Sung spousal, and bid haste the evening star  
On his hill-top to light the bridal lamp.  
These, lull'd by nightingales, embracing slept;  
And on their naked limbs the flowery roof  
Shower'd roses, which the morn repair'd.

These quotations from the best judge of melody, we thought due to the sweetest of our feathered choir-singers; and we believe no reader of taste will think them tedious.

Virgil seems to be the only poet among the ancients who hath attended to the circumstance of this bird's singing in the night time.

*Qualis populeæ merens Philomela sub umbrâ  
Amisso queritur fatuus, quos durus arator  
Observans nido implumes detraxit: at illa  
Flet noctem, ramoque sedens miserabile cormen  
Integrat, et majus late loco quævis implet.*

Georg. IV. l. 511.

As *Philomel* in poplar shades, alone,  
For her lost offspring pours a mother's moan,  
Which some rough ploughman marking for his prey,  
From the warm nest, unfeign'd hath dragg'd away;  
Percht on a bough, the all night long complains,  
And fills the grove with sad repeated strains. *F. Warton.*

Pliny has described the warbling notes of this bird, with an elegance that bespeaks an exquisite sensibility of taste, *lib. x. c. 29.*

If the nightingale is kept in a cage, it often begins to sing about the latter end of November, and continues its song more or less till June.—A young canary-bird, linnet, sky-lark, or robin (who have never heard any other bird), are said bred to learn the note of a nightingale.

NIGHTSHADE, in botany. See SOLANUM.

Deadly NIGHTSHADE. See ATROPA. The berries of this plant are of a malignant poisonous nature; and, being of a sweet taste, have frequently proved destructive to children. A large glass of warm vinegar, taken as soon as possible after eating the berries, will prevent their bad effects.

NIGIDIUS FIGULUS (Publius), one of the most learned men of ancient Rome, flourished at the same time with Cicero. He wrote on various subjects; but his pieces appeared so refined and difficult, that they were not regarded. He assisted Cicero, with great prudence, in defeating Catiline's conspiracy, and did him many services in the time of his adversity. He adhered to Pompey, in opposition to Cæsar; which occasioned his exile, he dying in banishment. Cicero, who had always entertained the highest esteem for him, wrote a beautiful consolatory letter to him, (the 13th of *lib. 4. ad Familiares*.)

NIGRITIA. See NEGROLAND.

NILE, a great river of Egypt in Africa, which has

has its source in Abyssinia, in about eight degrees north latitude. It runs generally from south to north through Abyssinia, Senna, and Nubia, into Egypt in one stream, till it comes below Cairo to the Delta, where it divides into several branches, the two principal of which discharge themselves into the Mediterranean, the one at Damietta, and the other at Rosetta. There are several cataracts in this river in Upper Egypt, but not so dreadful as ancient authors have reported. There are great rejoicings every year in Egypt when the Nile rises to a certain height, because their future harvest depends upon it. At the time of its rising they publish every day how many cubits and inches it is risen. But to know this, we must remember, that each cubit contains 24 inches: when the water is augmented to 16 cubits, then they open a sluice, which runs cross the city of Cairo; and when it is come to 22 cubits, it is reckoned very advantageous, if it ascends no higher: but if it rises to 24, it puts them into a terrible consternation, and then they publish that it extends from one mountain to the other. They are likewise in a great fright when the water ascends very slowly, because they are then afraid that it will not rise high enough to render the land fertile. The inundation generally continues from the 20th of July to the beginning of November; at which time the dry land begins to appear, if it can be called dry, after it has been so long soaked in the water. As soon as the land is fit, they sow their corn, and in April it becomes yellow and fit for reaping. When the water is let into the great canal, it is conveyed from thence into reservoirs and cisterns, to be distributed into their fields and gardens. But all the low wet places are sowed with rice, which grows best in the water. This overflowing of the Nile is owing to the great rains which fall annually between the tropics upon the high mountains of Abyssinia, near which the source of the Nile is, and from which the water falls down in great torrents into that river. The Nile does not contain a great number of fish, perhaps because there are so many crocodiles and other voracious animals. The water, when it is clear, is very fit for drinking.

**NIMBUS**, in antiquity, a circle observed on certain medals, or round the heads of some emperors; answering to the circles of light drawn round the images of saints.

**NIMEGUEN**, a large, handsome, and strong town of the Netherlands, and capital of Dutch Guelderland, with a citadel, an ancient palace, and several forts. It is noted for the peace concluded there in 1679. It has a magnificent town-house, and the inhabitants are greatly addicted to trade. It is seated on the Wahal or Wahal, between the Rhine and the Maese, in Long. 5. 50. Lat. 51. 55.

**NIMETULAHITES**, a kind of Turkish monks, so called from their founder Nimetulah, famous for his doctrines and the austerity of his life.

**NIMPO**, a city and sea-port town of China, in the province of Chekiang. It is seated on the eastern sea of China, over-against Japan. It is a city of the first rank, and stands at the confluence of two small rivers, which, after their union, form a channel that reaches to the sea, and is deep enough to bear vessels of 200 tons burthen. The walls of Nimpo are 5000 paces in circumference, and are built with free-stone.

There are five gates, besides two water-gates for the passage of barks into the city; a tower several stories high, built of bricks; and a long bridge of boats, fastened together with iron chains, over a very broad canal. This city is commanded by a citadel built on a very high rock, by the foot of which all vessels must necessarily pass. The Chinese merchants of Siam and Batavia go to this place yearly to buy silks, which are the finest in the empire. They have also a great trade with Japan, it being but two days sail from hence: thither they carry silks, stuffs, sugar, drugs, and wine; and bring back copper, gold, and silver. E. Long. 122. o. N. Lat. 30. o.

**NINEVEH** (anc. geogr.), a city of Assyria, which is thought to be one of the most ancient in the world. It was enlarged by Ninus, who some take to be the *Ninrod* of Moses. When Jonas went to preach against it, he was said to be three days in passing through it. It was a long while the capital of the Assyrian empire; but is now ruined, and it is hard to find the place where it stood.

**NINON LENCLOS**, a celebrated lady in the court of France, was of a noble family, and born at Paris in the year 1615; but rendered herself famous by her wit and gallantries. Her mother was a lady of exemplary piety; but her father early inspired her with the love of pleasure. Having lost her parents at 14 years of age, and finding herself mistress of her own actions, she resolved never to marry: she had an income of 10,000 livres a-year; and, according to the lessons she had received from her father, drew up a plan of life and gallantry, which she pursued till her death. Never delicate with respect to the number, but always in the choice, of her pleasures, she sacrificed nothing to interest; but loved only while her taste for it continued; and had among her admirers the greatest lords of the court. But though she was light in her amours, she had many virtues.—She was constant in her friendships; faithful to what are called the *laws of honour*; of strict veracity; disinterested; and more particularly remarkable for the exactest probity. Women of the most respectable characters were proud of the honour of having her for their friend: at her house was an assemblage of every thing most agreeable in the city and the court; and mothers were extremely desirous of sending their sons to that school of politeness and good taste, that they might learn sentiments of honour and probity, and those other virtues that render men amiable in society. But the illustrious Madame de Sevigné with great justice remarks in her letters, that this school was dangerous to religion and the Christian virtues; because Ninon Lenclous made use of seducing maxims, capable of depriving the mind of those invaluable treasures. Ninon was esteemed beautiful, even in old age; and is said to have inspired violent passions at 80. She died at Paris in 1705. This lady had several children; one of whom, named *Chevalier de Villiers*, occasioned much discourse by the tragical manner in which he ended his life. He became in love with Ninon, without knowing that she was his mother; and when he discovered the secret of his birth, stabbed himself in a fit of despair. There have been published the pretended letters of Ninon Lenclous to the marquis de Sevigné.

**NINTH**, in music. See INTERVAL.

Ninus  
Nisines

**NINUS**, the first king of the Assyrians, was, it is said, the son of Belus. It is added, that he enlarged Nineveh and Babylon; conquered Zoroaster king of the Bactrians; married Semiramis of Afcalon; subdued almost all Asia; and died after a glorious reign of 52 years, about 1150 B. C.; but all these facts are uncertain. See SEMIRAMIS.

**NIO**, an island of the Archipelago, between Naxi to the north, Armago to the east, Santerino to the south, and Sikino to the west, and is about 35 miles in circumference. It is remarkable for nothing but Homer's tomb, which they pretend is in this island; for they affirm that he died here in his passage from Samos to Athens. The island is well cultivated, and not so steep as the other islands, and the wheat which it produces is excellent; but oil and wood are scarce. It is subject to the Turks. E. Long. 25. 53. N. Lat. 36. 35.

**NIOBE**, in fabulous history, the daughter of Tantalus, and the wife of Amphion king of Thebes, was a princess of great beauty; but being the mother of seven sons and as many daughters, she had the presumption to prefer herself to Latona, who had only Apollo and Diana. Latona enraged at this contempt, caused Apollo and Diana to kill Niobe's 14 children with their arrows, the former slaying the sons, and the latter the daughters, in the embraces of their mother. On which Niobe being filled with the deepest grief, Jupiter, in compassion to her incessant tears, turned her into fone.

**NIPHON**, the largest of the Japan islands, being 600 miles long, and 100 broad. See JAPAN.

**NIPPERS**, in the menage, are four teeth in the fore-part of a horse's mouth, two in the upper, and two in the lower jaw. A horse puts them forth between the second and third year.

**NIPPLES**, in anatomy. See there, n° 376. c.

**NIPPLE-WORT**, in botany. See LAPSANA.

**NISI PRIUS**, in law, a judicial writ which lies in cases where the jury being impannelled and returned before the justices of the bank, one of the parties requests to have such a writ for the safe of the country, in order that the trial may come before the justices in the same county on their coming thither. The purport of a writ of *nisi prius* is, that the sheriff is thereby commanded to bring to Westminster the men impannelled, at a certain day, before the justices, "*nisi prius justiciarum domini regis ad assisas capiendas venerint.*"

**NISIBIS** (anc. geog.), a city both very ancient and noble, situate in a district called *Mygdonia*, in the north of Mesopotamia, towards the Tigris, from which it is distant two days journey. Some ascribe its origin to Nimrod, and suppose it to be the *Achad* of Moses. The Macedonians called it *Antiochia of Mygdonia*, (Plutarch); situate at the foot of mount Malus, (Strabo). It was the Roman bulwark against the Parthians and Persians, down to the emperor Jovianus; who, by an ignominious peace, delivered it up to the Persians. A colony, called *Septimia Nesibitana*.—Another *Nisibis*, of Aria, (Ptolemy), near the lake Arias.

**NISMES**, an ancient, large, and flourishing town of France, in Languedoc, with a bishop's see, and an academy. There are several monuments of antiquity,

of which the amphitheatre is the principal, built by the Romans. The *maison quarree*, or the square-house, is a piece of architecture of the Corinthian order, and one of the finest in the world. The temple of Diana is in part gone to ruin. It was taken by the English in 1417. The inhabitants were all Calvinists; but Lewis XIV. demolished their church in 1685, and built a castle to keep them in awe. It is seated in a delightful plain, abounding in wine, oil, game, and cattle. E. Long. 4. 26. N. Lat. 43. 50.

**NITHSDALE**, **NITHSDALE**, or **Niddisdale**, a division of Dumfriesshire in Scotland, lying to the westward of Annadale. It is a large and mountainous tract, deriving its name from the river Nid, which issues from a lake called *Loch-cure*, runs by the towns of Sanquhar, Morton, and Drumlanrig, and discharges itself into the Solway Frith. This country was formerly shaded with noble forests, which are now almost destroyed; so that, at present, nothing can be more naked, wild, and savage. Yet the bowels of the earth yields lead, and, as is said, silver and gold: the mountains are covered with sheep and black cattle; and here are still some considerable remains of the ancient woods, particularly that of Holywood, three miles from Dumfries, noted for an handsome church built out of the ruins of an ancient abbey; and also for being the birth-place of the famous astrologer, hence called *Joannes de Sacro Bosco*.

**NITRE**, or **SALTPETRE**. See CHEMISTRY, n° 184.

*Calcareous* NITRE. Ibid. n° 191.

*Cubic* NITRE. Ibid. n° 185.

**NITROUS**, any thing impregnated with nitre.

**NITROUS AIR**. See AIR, n° 36, 39.; **EUUDIEMETER**, note (B); and AIR, in the APPENDIX.

**NIVELLE**, a town of the Austrian Netherlands in the province of Brabant, remarkable for its abbey of Canonesses. Here is a manufacture of cambrics, and the town enjoys great privileges. The abbey just mentioned is inhabited by young ladies of the first quality, who are not confined therein as in nunneries, but may go out and marry whenever they fee convenient, or a proper match offers. E. Long. 4. 20. N. Lat. 50. 46.

**NIVELLE de la Chauvee** (Peter Claude), a comic poet, born at Paris; acquired great reputation by inventing a new kind of entertainment, which was called the *Weeping Comedy*. Instead of imitating Aristophanes, Terence, Moliere, and the other celebrated comic poets who had preceded him; and instead of exciting laughter by painting the different ridiculous characters, giving strokes of humour and absurdities in conduct; he applied himself to represent the weakness of the heart, and to touch and soften it. In this manner he wrote five comedies: 1. *La fausse Antipathie*. 2. *Le Prêjugé à la Mode*; this piece met with great success. 3. *Mélanide*. 4. *Amour pour Amour*; and, 5. *L'Ecole des Mères*. He was received into the French academy in 1736; and died at Paris in 1754, at 63 years of age. He also wrote a tragedy, intitled, *Maximianus*; and an epistle to Clio, an ingenious didactic poem.

**NIVERNOIS**, a province of France, with the title of a *duchy*, between Burgundy, Bourbonnois, and Barri. It is pretty fertile in wine, fruit, and corn; except the

part

Nithdale  
Nivernois



part called *Morvant*, which is a mountainous country, and barren. There is a great deal of wood, and several iron mines; as also mines of pit-coal, which serves to work their forges. This province is watered by a great number of rivers; of which the *Allier*, the *Loire*, and the *Yonne*, are navigable. *Nevers* is the capital city.

**NIXAPA**, a rich and considerable town in New Spain, with a rich convent of Dominicans. The country about it abounds in cochineal, indigo, and sugar. E. Long. 97. 25. N. Lat. 15. 20.

**NO**, (*Jeremiah*, *Ezekiel*), **NO-AMMON**, (*Nahum*); a considerable city of Egypt, thought to be the name of an idol which agrees with *Jupiter-Ammon*. The Septuagint translate the name in *Ezekiel*, *Diopolis*, "the city of Jupiter." *Bochart* takes it to be *Thebes* of Egypt; which, according to *Strabo* and *Ptolemy*, was called *Diopolis*. *Jerome*, after the *Chaldee* paraphrast *Jonathan*, supposes it to be *Alexandria*, named by way of anticipation; or an ancient city of that name is supposed to have stood on the spot where *Alexandria* was built.

**No-Man's-Land**, a space between the after-part of the belfrey and the fore-part of a ship's boat, when the said boat is stowed upon the booms, as in a deep-waisted vessel. These booms are laid from the fore-castle nearly to the quarter-deck, where their after-ends are usually sustained by a frame called the *gal-lows*, which consists of two strong posts, about six feet high, with a cross piece reaching from one to the other, athwart-ships, and serving to support the ends of those booms, masts, and yards, which lie in reserve to supply the place of others carried away, &c. The space called *No-man's-land* is used to contain any blocks, ropes, tackles, &c. which may be necessary on the fore-castle. It probably derives this name from its situation, as being neither on the starboard nor larboard side of the ship, nor on the waist or fore-castle; but, being situated in the middle, partakes equally of all those places.

**NOAH**, a famous patriarch, was the son of *Lamech*, and was born in 2978 B. C. He alone with his family were preserved from the universal deluge, when God exterminated the rest of the human race on account of their crimes. Having by the divine command built an ark, he entered it with his wife, his three sons and their wives, and animals of every kind, who were to multiply upon the earth after the deluge. *Noah* and all the living creatures staid a year in that vessel; and, on his coming out, he immediately expressed his gratitude by erecting an altar to the Lord, and offering sacrifices.—On which God blessed *Noah* and his family, and promised that the waters should no more overflow the whole earth. He died at the age of 950, 350 years after the deluge; leaving three sons, *Shem*, *Ham*, and *Japheth*, from whom sprung the whole human race.

**NOBILIARY**, in literary history, a book containing the history of the noble families of a nation, or province: such are *Chorier's Nobiliary of Dauphine*, and *Caumartin's Nobiliary of Provence*. The Germans are said to be particularly careful of their Nobiliaries, in order to keep up the dignity of their families.

**NOBILITY**, a quality that ennobles, and raises

a person possessed of it above the rank of a commoner.

The origin of nobility in Europe is by some referred to the *Goths*; who, after they had seized a part of Europe, rewarded their captains with titles of honour, to distinguish them from the common people.—In this place we shall consider the manner in which they may be created, and the incidents attending them.

1. The right of peerage seems to have been originally territorial; that is, annexed to lands, honours, castles, manors, and the like, the proprietors and possessors of which were (in right of those estates) allowed to be peers of the realm, and were summoned to parliament to do suit and service to their sovereign; and, when the land was alienated, the dignity passed with it as appendant. Thus the bishops (till fit in the house of lords in right of succession to certain ancient baronies annexed, or supposed to be annexed, to their episcopal lands; and thus, in 11 Hen. VI. the possession of the castle of *Arundel* was adjudged to confer an earldom on its possessor. But afterwards, when *ALIENATIONS* grew to be frequent, the dignity of peerage was confined to the lineage of the party ennobled, and instead of territorial became personal. Actual proof of a tenure by barony became no longer necessary to constitute a lord of parliament; but the record of the writ of summons to him or his ancestors was admitted as a sufficient evidence of the tenure.

Peers are now created either by writ or by patent; for those who claim by prescription must suppose either a writ or patent made to their ancestors; tho' by length of time it is lost. The creation by writ, or the king's letter, is a summons to attend the house of peers, by the style and title of that barony which the king is pleased to confer: that by patent is a royal grant to a subject of any dignity and degree of peerage. The creation by writ is the more ancient way; but a man is not ennobled thereby, unless he actually take his seat in the house of lords: and some are of opinion that there must be at least two writs of summons, and a sitting in two distinct parliaments, to evidence an hereditary barony: and therefore the most usual, because the surest, way is to grant the dignity by patent, which endures to a man and his heirs according to the limitations thereof, though he never himself makes use of it. Yet it is frequent to call up the eldest son of a peer to the house of lords by writ of summons, in the name of his father's barony: because in that case there is no danger of his children's losing the nobility in case he never takes his seat; for they will succeed to their grandfather. Creation by writ has also one advantage over that by patent: for a person created by writ holds the dignity to him and his heirs, without any words to that purport in the writ; but in letters patent there must be words to direct the inheritance, else the dignity endures only to the grantee for life. For a man or woman may be created noble for their own lives, and the dignity not descend to their heirs at all, or descend only to some particular heirs: as where a peerage is limited to a man and the heirs male of his body by *Elizabeth* his present lady, and is not to such heirs by any former or future wife.

2. Let us next take a view of a few of the principal incidents attending the nobility,—exclusive of their capacity

Nobility.

capacity as members of parliament, and as hereditary counsellors of the crown, both of which we have considered under the articles LORDS and PARLIAMENT. And first we must observe, that in criminal cases a nobleman shall be tried by his peers. The great are always obnoxious to popular envy: were they to be judged by the people, they might be in danger from the prejudice of their judges; and would moreover be deprived of the privilege of the meanest subjects, that of being tried by their equals, which is secured to all the realm by magna carta, c. 29. It is said, that this does not extend to bishops; who, though they are lords of parliament, and sit there by virtue of their baronies which they hold *jure ecclesie*, yet are not ennobled in blood, and consequently not peers with the nobility. As to peeresses, no provision was made for their trial when accused of treason or felony, till after Eleanor duchess of Gloucester, wife to the lord protector, had been accused of treason, and found guilty of witchcraft, in an ecclesiastical synod, through the intrigues of cardinal Beaufort. This very extraordinary trial gave occasion to a special statute, 20 Hen. VI. c. 9. which enacts, that peeresses, either in their own right or by marriage, shall be tried before the same judicature as peers of the realm. If a woman, noble in her own right, marries a commoner, she still remains noble, and shall be tried by her peers: but if she be only noble by marriage, then by a second marriage with a commoner she loses her dignity; for by marriage it is gained, by marriage it is also lost. Yet if a duchess-dowager marries a baron, she continues a duchess still; for all the nobility are *parcs*, and therefore it is no degradation. A peer or peeress (either in her own right or by marriage) cannot be arrested in civil cases: and they have also many peculiar privileges annexed to their peerage in the course of judicial proceedings. A peer sitting in judgment, gives not his verdict upon oath, like an ordinary jurymen, but upon his honour; he answers also to bills in chancery upon his honour, and not upon his oath; but, when he is examined as a witness either in civil or criminal cases, he must be sworn; for the respect which the law shews to the honour of a peer does not extend so far as to overturn a settled maxim, that *in judicio non creditur nisi juratis*. The honour of peers is however so highly tendered by the law, that it is much more penal to spread false reports of them, and certain other great officers of the realm, than of other men: scandal against them being called by the peculiar name of *scandalum magnatum*, and subjected to peculiar punishment by divers ancient statutes.

A peer cannot lose his nobility but by death or attainder; though there was an instance, in the reign of Edward the fourth, of the degradation of George Nevile duke of Bedford by act of parliament, on account of his poverty, which rendered him unable to support his dignity. But this is a singular instance: which serves at the same time; by having happened, to shew the power of parliament; and, by having happened but once, to shew how tender the parliament hath been, in exerting so high a power. It hath been said indeed, that if a baron waives his estate, so that he is not able to support the degree, the king may degrade him: but it is expressly held by later

authorities, that a peer cannot be degraded but by act of parliament.

NOBLE, a money of account containing six shillings and eight pence.

The noble was anciently a real coin struck in the reign of Edward III. and then called the *ponny of gold*; but it was afterwards called a *rose-noble*, from its being stamped with a rose: it was current at 6s. 8d.

NOCERA, an ancient town of Italy, in the duchy of Spoleto, and in the territory of the pope, with a bishop's see; seated at the foot of the Appennines, E. Long. 12. 55. N. Lat. 43. 2.

Terra NOCERIANA, *Earth of Nocera*, in the materia medica, a species of bole remarkably heavy, of a greyish-white colour, of an insipid taste, and generally with some particles in it which grit between the teeth. It is much esteemed by the Italians, as a remedy for venomous bites, and in fevers; but, excepting as an absorbent and astringent, no dependence is to be had on it.

NOCTAMBULI, NOCTAMBULONES, or *Night-walkers*; a term of equal import with *sonnambuli*, applied to persons who have a habit of rising and walking about in their sleep. The word is a compound of the Latin *nox*, "night," and *ambulo*, "I walk."

Schenckius, Hortsius, Clauderus, and Hildanus, who have wrote of sleep, give us divers unhappy histories of such noctambuli. When the disease is moderate, the persons affected with it only repeat the actions of the day on getting out of bed, and go quietly to the places they frequented at other times; but those who have it in the most violent degree, go up to dangerous places, and do things which would terrify them to think of when they are awake. These are by some called *lunatic* night-walkers, because fits are observed to return with the most frequency and violence at the changes of the moon.—For the cure some recommend purging and a cooling regimen: others are of opinion that the best method is to place a vessel of water at the patient's bed-side in such a manner that he will naturally step into it when he gets out of bed; or if that should fail, a person should sit up to watch and beat him every time it happens.

NOCTILUCA, a species of phosphorus, so called because it shines in the dark without any light being thrown upon it: such is the phosphorus made of urine.

NOCTURNAL, something relating to the night, in contradiction to diurnal.

NOCTURNAL, *Nocturlabium*, an instrument chiefly used at sea, to take the altitude or depression of some stars about the pole, in order to find the latitude and hour of the night.

Some nocturnals are hemispheres, or planispheres, on the plane of the equinoctial. Those commonly in use among seamen are two; the one adapted to the polar star, and the first of the guards of the little bear; the other to the pole star, and the pointers of the great bear.

This instrument consists of two circular plates, applied to each other. The greater, which has a handle to hold the instrument, is about 2½ inches diameter, and is divided into twelve parts, agreeing to the twelve months; and each month subdivided into every

Noble  
||  
Nocturnal.

Nocturnal  
Nodes.Nodus  
Nolle.Plate CCI.  
fig. 2.

fifth day; and so as that the middle of the handle corresponds to that day of the year wherein the star here regarded has the same right ascension with the sun. If the instrument be fitted for two stars, the handle is made moveable. The upper left circle is divided into twenty-four equal parts for the twenty-four hours of the day, and each hour subdivided into quarters. These twenty-four hours are noted by twenty-four teeth to be told in the night. Those at the hours 12, are distinguished by their length. In the centre of the two circular plates is adjusted a long index, moveable upon the upper plate. And the three pieces, viz. the two circles and index, are joined by a rivet which is pierced through the centre with a hole, through which the star is to be observed.

To use the nocturnal, turn the upper plate till the long tooth, marked 12, be against the day of the month on the under plate: then, bringing the instrument near the eye, suspend it by the handle with the plane nearly parallel to the equinoctial; and viewing the pole star through the hole of the centre, turn the index about, till, by the edge coming from the centre, you see the bright star or guard of the little bear, (if the instrument be fitted to that star): then that tooth of the upper circle, under the edge of the index, is at the hour of the night on the edge of the hour-circle: which may be known without a light, by counting the teeth from the longest, which is for the hour 12.

**NODATED HYPERBOLA**, a name given by Sir Isaac Newton to a kind of hyperbola, which, by turning round, decussates or crosses itself.

**NODE**, a tumour arising on the bones, and usually proceeding from some venereal cause; being much the same with what is otherwise called *exostosis*.

**NODES**, in astronomy, the two points where the orbit of a planet intersects the ecliptic.

Plate CCIV.  
fig. 4. n<sup>o</sup> 1.

Such are the two points C and D; of which the node C, where the planet ascends northward above the plane of the ecliptic, is called the *ascending node*, or the *dragon's head*, and is marked thus  $\Omega$ . The other node D, where the planet descends to the south, is called the *descending node*, or the *dragon's tail*, marked thus  $\omega$ .

The line CD, wherein the two circles C E D F and C G D H intersect, is called the *line of nodes*. It appears from observation, that the line of the nodes of all the planets, constantly changes its place, and shifts its situation from east to west, contrary to the order of the signs; and that the line of the moon's nodes, by a retrograde motion, finishes its circulation in the compass of 19 years; after which time, either of the nodes having receded from any point of the ecliptic, returns to the same again; and when the moon is in the node, she is also seen in the ecliptic. If the line of nodes were immovable, that is, if it had no other motion than that whereby it is carried round the sun, it would always look to the same point of the ecliptic, or would keep parallel to itself, as the axis of the earth does.

From what hath been said, it is evident, that the moon can never be observed precisely in the ecliptic, but twice in every year; that is, when she enters the nodes. When she is at her greatest distance from the nodes; viz. in the points E, F, she is said to be

in her limits.

The moon must be in or near one of the nodes, when there is an eclipse of the sun or moon.

To make the foregoing account of the motion of moon's nodes still clearer, let the plane of n<sup>o</sup> 2. *ibid.* represent that of the ecliptic, S the sun, T the centre of the earth, L the moon in her orbit D N d n. N n is the line of the nodes passing between the quadrature Q q and the moon's place L, in her last quarter. Let now L P, or any part L S, represent the excess of the sun's action at T; and this being resolved into the force L R, perpendicular to the plane of the moon's orbit, and P R parallel to it, it is the former only that has any effect to alter the position of the orbit, and in this it is wholly exerted. Its effect is twofold: 1. It diminishes its inclination by a motion which we may conceive as performed round the diameter D d, to which L T is perpendicular. 2. Being compounded with the moon's tangential motion at L, it gives it an intermediate direction L t, through which, and the centre, a plane being drawn, must meet the ecliptic nearer the conjunction C than before.

**NODUS**, or node, in dialling, a certain point or pole in the gnomon of a dial, by the shadow or light whereof either the hour of the day in dials without furniture, or the parallels of the sun's declination, and his place in the ecliptic, &c. in dials with furniture, are shewn. See **DIALLING**.

**NOEOMAGUS LEXUVIURUM**, (Ptol.) ; thought to be the *Givita Lexoviorum* of the lower age. Now *Lisieux*, a city in Normandy.—Another of the *Tricassini*; a town of Gallia Narbonensis; thought to be *S. Pol de Trois Châteaux*, six miles to the west of Nyons in Dauphiné.

**NOETIANS**, in church-history, Christian heretics in the third century, followers of Noctius, a philosopher of Ephesus, who pretended that he was another Moses sent by God, and that his brother was a new Aaron. His heresy consisted in affirming that there was but one person in the Godhead; and that the Word and the Holy Spirit were but external denominations given to God in consequence of different operations: that as Creator, he is called *Father*; as Incarnate, *Son*; and as descending on the apostles, *Holy Ghost*.

**NOLA**, a very ancient city, formerly populous and strong, situate in a plain to the north-east of Vesuvius in Campania, said to be built by the Chalchidians, (Justin, Silius Italicus); according to others, by the Tuscans. At this place Hannibal met with the first check by Marcellus. Vespasian added the appellation *Augusta Colonia*, (Frontinus). At this place, or in its neighbourhood, Augustus is said to have expired. At this day retaining its old name, but fallen short of its ancient splendour. A town of the kingdom of Naples. E. Long. 15. N. Lat. 41. 5.

**NOLLE PROSEQUI**, is where a plaintiff in an action does not declare in a reasonable time; in which case it is usual for the defendant's attorney to enter a rule for the plaintiff to declare, after which a *non pro* may be entered. A *nolle prosequi* is esteemed a voluntary confession, that the plaintiff has no cause of action: and therefore if a plaintiff enter his *nolle prosequi*, he shall be amerced; and if an informer cause the same to be entered, the defendant shall have costs.

NOMADES,

Nomades  
||  
Nominals.

**NOMADES**, a name given, in antiquity, to several nations or people whose whole occupation was to feed and tend their flocks; and who had no fixed place of abode, but were constantly shifting, according to the conveniences of pasturage.—The word comes from the Greek *νομᾶν, pasco*, “I feed.”

The most celebrated among the Nomades were those of Africa, who inhabited between Africa, properly so called, to the east, and Mauritania to the west. They are also called *Numide*, or *Numidians*.—Sallust says, they were a colony of Perians brought into Africa with Hercules.

The Nomades of Asia inhabited the coasts of the Caspian Sea.—The Nomades of Scythia were the inhabitants of Little Tartary; who still retain the ancient manner of living.

**NOMARCHA**, in antiquity, the governor or commander of a nome, or nomos.—Egypt was anciently divided into several regions or quarters, called *nomes*, from the Greek *νομῶς*; taken in the sense of a division; and the officer who had the administration of each *nome*, or *nomos*, from the king, was called *monarcha*, from *νομῶς* and *αρχη*. “command.”

**NOMBRE-DE-DIOS**, a town of Mexico, in the province of Darien, a little to the eastward of Porto-Bello. It was formerly a famous place; but it is now abandoned, on account of its unhealthy situation. W. Long. 78. 35. N. Lat. 9. 43.

**NOMBRIL POINT**, in heraldry, is the next below the fess point, or the very centre of the escutcheon.

Supposing the escutcheon divided into two equal parts below the fess, the first of these divisions is the nombril, and the lower the base.

**NOME**, or **NAME**, in algebra, denotes any quantity with a sign prefixed or added to it, whereby it is connected with some other quantity, upon which the whole becomes a binomial, trinomial, or the like. See ALGEBRA.

**NOMENCLATOR**, in Roman antiquity, was usually a slave who attended upon persons that stood candidates for offices, and prompted or suggested to them the names of all the citizens they met, that they might court them and call them by their names, which among that people was the highest piece of civility.

**NOMENCLATORS**, among the botanical authors, are those who have employed their labours about settling and adjusting the right names, synonyms, and etymologies of names, in regard to the whole vegetable world.

**NOMENCLATURE**, **NOMENCLATURA**, a catalogue of several of the more usual words in any language, with their significations, compiled in order to facilitate the use of such words to those who go to learn the tongue: such are our Latin, Greek, French, &c. Nomenclatures.

**NOMENEY**, a town of Germany, in the duchy of Lorraine, situated on the river Seille, 15 miles north of Nancy.

**NOMINALS**, or **NOMINALISTS**, a sect of school-philosophers, the disciples and followers of Occam, or Ocham, an English cordelier, in the 14th century. They were great dealers in words, whence they were vulgarly denominated *Word-sellers*; but had the denomination of *Nominalists*, because that, in opposition to

the *Realists*, they maintained, that words, and not things, were the object of dialectics.

**NOMINATIVE**, in grammar, the first CASE of nouns which are declinable.

The simple position, or laying down of a noun, or name, is called the *nominative case*; yet it is not so properly a case, as the matter or ground, whence the other cases are to be formed, by the several changes and inflections given to this first termination. Its chief use is to be placed in discourse before all verbs, as the subject of the proposition or affirmation.

**NONAGE**, in law, generally signifies all the time a person continues under the age of 21; but, in a special sense, it is all the time that a person is under the age of 14.

**NON-CAPE**, a promontory on the west coast of Africa, opposite to the Canary islands. W. Long. 12. o. N. Lat. 44. 28.

**NONCONFORMISTS**, those who refuse to join the established worship.

Nonconformists, in England, are of two sorts. First, such as absent themselves from divine worship in the established church through total irreligion, and attend the service of no other persuasion. These, by the stat. i. Eliz. c. 2. 23 Eliz. c. 1. and 3 Jac. 1. c. 4. forfeit one shilling to the poor every Lord's-day they go absent themselves, and 20l. to the king if they continue such default for a month together. And if they keep any inmate thus irreligiously disposed in their houses, they forfeit 10l. *per month*.

The second species of nonconformists are those who offend through a mistaken or perverse zeal. Such were esteemed, by the English laws enacted since the time of the Reformation, to be Papists and Protestant dissenters: both of which were supposed to be equally schismatics, in not communicating with the national church; with this difference, that the Papists divided from it upon material, though erroneous, reasons; but many of the dissenters upon matters of indifference, or, in other words, upon no reason at all. “Yet certainly (says Sir William Blackstone) our Ancestors were mistaken in their plans of compulsion and intolerance. The sin of schism, as such, is by no means the object of temporal coercion and punishment. If, through weakness of intellect, through misdirected piety, through perverseness and acerbity of temper, or (which is often the case) through a prospect of secular advantage in herding with a party, men quarrel with the ecclesiastical establishment, the civil magistrate has nothing to do with it; unless their tenets and practice are such as threaten ruin or disturbance to the state. He is bound indeed to protect the established church: and if this can be better effected by admitting none but its genuine members to offices of trust and emolument, he is certainly at liberty so to do; the disposal of offices being matter of favour and discretion. But, this point being once secured, all persecution for diversity of opinions, however ridiculous or absurd they may be, is contrary to every principle of sound policy and civil freedom. The names and subordination of the clergy, the posture of devotion, the materials and colour of the minister's garment, the joining in a known or unknown form of prayer, and other matters of the same kind, must be left to the option of every man's private judgment.”

Nominative  
||  
Nonconformists.

Blackst.  
Comment.

Noncon-  
formists.Noncon-  
formists.Blackst.  
Comment.

“ With regard therefore to *Protestant dissenters*, although the experience of their turbulent disposition in former times occasioned several disabilities and restrictions (which I shall not undertake to justify) to be laid upon them by abundance of statutes; yet at length the legislature, with a true spirit of magnanimity, extended that indulgence to these sectaries, which they themselves, when in power, had held to be countenancing schism, and denied to the church of England. The penalties are conditionally suspended by the statute 1 W. & M. II. c. 18. “ for exempting their Majesties Protestant subjects, dissenting from the church of England, from the penalties of certain laws,” commonly called the *toleration act*; which declares, that neither the laws above-mentioned, nor the statutes 1 Eliz. c. 2. § 14. § Jac. I. c. 4. & 5. nor any other penal laws made against Popish recusants (except the test-acts) shall extend to any dissenters, other than Papists and such as deny the Trinity: provided, 1. That they take the oaths of allegiance and supremacy, (or make a similar affirmation, being Quakers), and subscribe the declaration against Popery. 2. That they repair to some congregation certified to, and registered in the court of the bishop or archdeacon, or at the county-sessions. 3. That the doors of such meeting-house shall be unlocked, unbarred, and unbolted; in default of which, the persons meeting there are still liable to all the penalties of the former acts. Dissenting teachers, in order to be exempted from the penalties of the statutes 13 & 14 Car. II. c. 4. 17 Car. II. c. 2. and 22 Car. II. c. 1. are also to subscribe the articles of religion mentioned in the statute 13 Eliz. c. 12. (viz. those which only concern the confession of the true Christian faith, and the doctrine of the sacraments), with an express exception of those relating to the government and powers of the church, and to infant-baptism. And by statute 10 Ann. c. 2. this toleration is ratified and confirmed; and it is declared, that the said act shall at all times be inviolably observed for the exempting such Protestant dissenters as are thereby intended, from the pains and penalties therein mentioned. Thus, though the offence of nonconformity is by no means universally abrogated, it is suspended, and ceases to exist with regard to these Protestant dissenters, during their compliance with the conditions imposed by the act of toleration: and, under these conditions, all persons, who will approve themselves no Papists or oppugners of the Trinity, are left at full liberty to act as their consciences shall direct them in the matter of religious worship. And if any person shall wilfully, maliciously, or contemptuously disturb any congregation, assembled in any church or permitted meeting-house, or shall misuse any preacher or teacher there, he shall (by virtue of the same statute) be bound over to the sessions of the peace, and forfeit 20 l. But by statute 5 Geo. I. c. 4. no mayor or principal magistrate must appear at any dissenting meeting with the ensigns of his office, on pain of disability to hold that or any other office: the legislature judging it a matter of propriety, that a mode of worship, set up in opposition to the national, when allowed to be exercised in peace, should be exercised also with decency, gratitude, and humility. Neither doth the act of toleration extend to enervate those clauses of the statutes 14 & 13 Car. II. c. 4. & 17

Car. II. c. 2. which prohibit (upon pain of fine and imprisonment) all persons from teaching school, unless they be licensed by the ordinary, and subscribe a declaration of conformity to the liturgy of the church, and reverently frequent divine service *established* by the laws of this kingdom.

“ As to *Papists*, what has been said of the Protestant dissenters would hold equally strong for a general toleration of them; provided their separation was founded only upon difference of opinion in religion, and their principles did not also extend to a subversion of the civil government. If once they could be brought to renounce the supremacy of the Pope, they might quietly enjoy their seven sacraments; their purgatory, and auricular confession; their worship of relics and images; nay, even their transubstantiation. But while they acknowledge a foreign power, superior to the sovereignty of the kingdom, they cannot complain if the laws of that kingdom will not treat them upon the footing of good subjects.

“ The following are the laws that have been enacted against the Papists; who may be divided into three classes, persons professing Popery, Popish recusants convicted, and Popish priests. 1. Persons professing the Popish religion, besides the former penalties for not frequenting their parish-church, are disabled from taking any lands either by descent or purchase, after 18 years of age, until they renounce their errors; they must at the age of 21 register their estates before acquired, and all future conveyances and wills relating to them; they are incapable of presenting to any advowson, or granting to any other person any avoidance of the same; they may not keep or teach any school under pain of perpetual imprisonment; and, if they willingly say or hear mass, they forfeit the one 200, the other 100 marks, and each shall suffer a year’s imprisonment. Thus much for persons who, from the misfortune of family-prejudices, or otherwise, have conceived an unhappy attachment to the Romish church from their infancy, and publicly profess its errors. But if any evil industry is used to rivet these errors upon them; if any person sends another abroad to be educated in the Popish religion, or to reside in any religious house abroad for that purpose, or contributes to their maintenance when there; both the sender, the sent, and the contributor, are disabled to sue in law or equity, to be executor or administrator to any person, to take any legacy or deed of gift, and to bear any office in the realm; and shall forfeit all their goods and chattels, and likewise all their real estate for life. And where these errors are also aggravated by apostasy or perversion; where a person is reconciled to the see of Rome, or procures others to be reconciled, the offence amounts to high-treason. 2. Popish recusants, convicted in a court of law of not attending the service of the church of England, are subject to the following disabilities, penalties, and forfeitures, over and above those before-mentioned. They are considered as persons excommunicated; they can hold no office or employment; they must not keep arms in their houses, but the same may be seized by the justices of the peace; they may not come within 10 miles of London, on pain of 100 l.; they can bring no action at law or suit in equity; they are not permitted to travel above five miles from home, unless by li-

Nonconformists.

confe, upon pain of forfeiting all their goods; and they may not come to court under pain of 100 l. No marriage or burial of fuch recusant, or baptifm of his child, fhall be had otherwife than by the minifters of the church of England, under other fevere penalties. A married woman, when recusant, fhall forfeit two thirds of her dower or jointure, may not be executrix or adminiftratrix to her husband, nor have any part of his goods; and during the coverture may be kept in prifon, unlefs her husband redeems her at the rate of 10 l. a month, or the third part of all his lands. And laftly, as a feme-covert recusant may be imprifoned, fo all others mult, within three months after conviction, either fubmit and renounce their errors, or, if required fo to do by four juftices, mult abjure and renounce the realm: and if they do not depart, or if they return without the king's licence, they fhall be guilty of felony, and fuffer death as felons without benefit of clergy. There is alfo an inferior fpecies of recufancy, (refufing to make the declaration againft Popery enjoined by ftatute 30 Car. II. ff. 2. when tendered by the proper magiftrate); which, if the party refides within ten miles of London, makes him an abfolute recusant convict; or, if at a greater diftance, fufpends him from having any feat in parliament, keeping arms in his houfe, or any horfe above the value of 5 l. 3. Popifh priests are in a ftill more dangerous condition. By ftatute 11 & 12 W. III. c. 4. Popifh priests, or bifhops, celebrating mafs or exercifing any part of their functions in England, except in the houfes of ambafadors, are liable to perpetual imprifonment. And by the ftatute 27 Eliz. c. 2. any Popifh priest, born in the dominions of the crown of England, who fhall come over hither from beyond fea, (unlefs driven by ftrefs of weather and tarrying only a reafonable time), or fhall be in England three days without conforming and taking the oaths, is guilty of high treason: and all perfons harbouring him are guilty of felony without the benefit of clergy.

This is a fhort fummary of the laws againft the Papifts; of which the prefident Montefquieu obferves, that they are fo rigorous, though not profefsedly of the fanguinary kind, that they do all the hurt that can poffibly be done in cold blood. But in anfwer to this it may be obferved, (what foreigners who only judge from our ftatute-book are not fully apprized of) that thefe laws are feldom exerted to their utmoft rigour: and indeed, if they were, it would be very difficult to excufe them. For they are rather to be accounted for from their hiftory, and the urgency of the times which produced them, than to be approved (upon a cool review) as a ftanding fyftem of law. The reftlefs machinations of the Jefuits during the reign of Elizabeth, the turbulence and uncafinefs of the Papifts under the new religious eftablifhment, and the boldnefs of their hopes and wifhes for the fucceffion of the queen of Scots, obliged the parliament to counteract fo dangerous a fpirit by laws of a great, and then perhaps neceffary, feverity. The powder-treason, in the fucceeding reign, ftrook a panic into James I. which operated in different ways: it occafioned the enacting of new laws againft the Papifts; but deterred him from putting them in execution. The intrigues of queen Henrietta in the reign of Charles I. the profpect of a Popifh fucceffor in that of Char. II.

the affaffination-plot in the reign of king William, and the avowed claim of a Popifh pretender to the crown in fubfequent reigns, will account for the extension of thefe penalties at thofe feveral periods of our hiftory." But now that all juft fears of a pretender may be faid to have vanifhed; and the power and influence of the pope has become feeble, ridiculous, and defpicable, not only in Britain, but in almoft every kingdom of Europe; and as in fact the Britifh Catholics folemnly difclaim the dangerous principles afcribed to them; the Britifh legiflature, giving way to that liberality of fentiment becoming Proteftants, has lately repealed the moft rigorous of the above edicts, viz. The punifhment of Popifh priests or Jefuits who fhould be found to teach or officiate in the fervices of that church; which acts were felony in foreigners, and high treason in the natives of this kingdom:—The forfeitures of Popifh heirs, who had received their education abroad; and whole eftates went to the next Proteftant heir:—The power given to the fon, or other relation, being a Proteftant, to take poffeffion of the father's or other relation's eftate, during the life of the real proprietor:—And the debarring Papifts from the power of acquiring any legal property by purchafe.—In propofing the repeal of thefe penalties, it was obferved, That, befides that fome of them had now ceafed to be neceffary, others were at all times a difgrace to humanity. The imprifonment of a Popifh prieft for life, only for officiating in the fervices of his religion, was horrible in its nature: And although the mildnefs of government had hitherto foftened the rigour of the law in the practice, it was to be remembered that the Roman Catholic priests continually lay at the mercy of the beft and moft abandoned of mankind—of common informers; for on the evidence of any of thefe wretches, the magiftrical and judicial powers were of neceffity bound to enforce all the shameful penalties of the act. Others of thefe penalties held out the moft powerful temptations for the commiffion of acts of depravity, at the very thought of which our nature recoils with horror: They feemed calculated to loofen all the bands of fociety; to difolve all civil, moral, and religious obligations and duties, to poifon the fources of domeftic felicity, and to annihilate every principle of honour. The encouragement given to children to lay their hands upon the eftates of their parents, and the reftriction which debars any man from the honeft acquisition of property, need only to be mentioned to excite indignation in an enlightened age.

In order the better to fecure the English eftablifhed church againft perils from non-conformifts of all denominations, infidels, Turks, Jews, heretics, Papifts, and fectaries, there are, however, two bulwarks erected; called the *corporation* and *teft acts*: By the former of which, no perfon can be legally elected to any office relating to the government of any city or corporation, unlefs, within a twelvemonth before, he has received the facrament of the Lord's fupper according to the rights of the church of England; and he is alfo enjoined to take the oaths of allegiance and fupremacy at the fame time that he takes the oath of office: or, in default of either of thefe requifites, fuch election fhall be void. The other, called the *teft acts*, directs all officers civil and military to take the oaths and make the declaration againft tranfubftantiation, in any

Nonconformists.

† See their Royal Ad-drefs to the throne, May 1. 1773, as inserted in the Magazines or Annual Register for that year.

Non  
Nonius.

of the king's courts at Westminster, or at the quarter-sessions, within six calendar months after their admission; and also within the same time to receive the sacrament of the Lord's supper, according to the usage of the church of England, in some public church immediately after divine service and sermon, and to deliver into court a certificate thereof signed by the minister and church-warden, and also to prove the same by two credible witnesses; upon forfeiture of 500l. and disability to hold the said office. And of such the same nature with these is the statute 7 Jac. I. c. 2. which permits no persons to be naturalized or restored in blood, but such as undergo a like test: which test having been removed in 1753, in favour of the Jews, was the next session of parliament restored again with some precipitation.

*Non-Naturals*, in medicine, so called, because by their abuse they become the causes of diseases.

Physicians have divided the non-naturals into six classes, viz. the air, meats and drinks, sleep and watching, motion and rest, the passions of the mind, the retentions and excretions. See *MEDICINE*, n° 147, &c.

*Non Obstante*, (*notwithstanding*), a clause frequent in statutes and letters-patent, importing a licence from the king to do a thing, which at common law might be lawfully done, but being restrained by act of parliament cannot be done without such licence.

*Non Prox.* See *NOLLE Prosequi*.

*Non-Suit*, signifies the dropping of a suit or action, or a renouncing thereof by the plaintiff or defendant; which happens most commonly upon the discovery of some error in the plaintiff's proceedings when the cause is so far proceeded in, that the jury is ready at the bar to deliver in their verdict.

*NONES*, (ἄονες) in the Roman kalendar, the fifth day of the months January, February, April, June, August, September, November, and December; and the seventh of March, July, and October. March, May, July, and October, had six days in their nones; because these alone, in the ancient constitution of the year by Numa, had 31 days a-piece, the rest having only 29, and February 30: but when Cæsar reformed the year, and made other months contain 31 days, he did not allot them six days of nones.

*NONIUS* (Peter), in Spanish *Nunz*, a learned Portuguese, and one of the ablest mathematicians of the 16th century, was born at Alcazar. He was preceptor to Don Henry, king Emmanuel's son, and taught the mathematics in the university of Coimbra. He published the following works, by which he gained great reputation: 1. *De arte navigandi*. 2. *Annotationes in theorias planetarum Purbachii*; which are greatly esteemed. 3. A treatise *De crepusculis*. 4. A treatise on algebra. It is observed in Furetiere's dictionary, that Peter Nonius, in 1530, first invented the angles of 45 degrees made in every meridian, and that he called them *rumbis* in his language, and calculated them by spherical triangles. Nonius died in 1577, aged 80.

*NONIUS* (Marcellus), a grammarian and Peripatetic philosopher, born at Tivoli, wrote a treatise, intitled *De proprietate sermonum*. This author is only valuable for his giving fragments of ancient authors that are nowhere else to be found. The above treatise

was printed at Paris in 1614, with notes.

*NONNIUS*, or *NONIUS* (Lewis), a learned physician of Antwerp in the 17th century, wrote several works which are esteemed; the principal of which are, 1. An excellent treatise intitled *Ichthyophagia, sive de Piscium esu*. 2. *Hispania*; which is of great use in understanding the ancient geography of Spain. 3. A commentary on the medals of Greece, and those of Julius Cæsar, Augustus, and Tiberius, in folio: it contains Goltzius's two works on the same subject. 4. A commentary on Goltzius's account of Greece, the islands, &c. 5. Poems, &c.

*NONNUS*, a Greek poet of the 5th century, and native of Panopolis in Egypt, was the author of an heroic poem in 48 books, intitled *Dionysiacorum*, and a paraphrase in verse of St John's Gospel, which may serve as a commentary upon it.

*NORDEN* (Frederic Lewis), an ingenious traveller and naval officer in the Danish service, was born at Gluckstadt in Holstein in the year 1708. He was well skilled in mathematics, ship-building, and especially in architecture; and in 1732 obtained a pension to enable him to travel for the purpose of studying the construction of ships, particularly the galleys and other rowing vessels used in the Mediterranean. He spent near three years in Italy, and Christian VI. being desirous of obtaining a circumstantial account of Egypt, Mr Norden at Florence received an order to extend his travels to that country. How he acquitted himself in this commission, appears from his Travels into Egypt and Nubia, printed at Copenhagen in folio, 1756; and which were soon after translated into English by Dr Peter Templeman. In the war between England and Spain, Mr Norden, then a captain in the Danish navy, attended count Ulric Adolphus, a sea-captain, to England; and they went out volunteers under Sir John Norris, and afterwards under Sir Chaloner Ogle. During his stay in London, Mr Norden was made a fellow of the royal society, and gave the public drawings of some ruins and colossal statues at Thebes in Egypt; with an account of the same, in a letter to the royal society, 1741. His health at this time was declining; and taking a tour to France, he died at Paris in 1742.

*NORFOLK*, a county of England, so called from its northern situation in respect of Suffolk, is bounded on the east and north by the German ocean; on the south by Suffolk, from which it is parted by the rivers Waveney, and the Lesser Ouse; and on the west it is separated from Cambridgeshire by the Greater Ouse, and from a small part of Lincolnshire by the washes. According to Templeman, it extends in length 57 miles, in breadth 35, and 140 in circumference. It contains an area of 1426 square miles, one city, 32 market-towns, 711 villages, according to the book of rates; though some make them 1500, and 236000 inhabitants, as some have it, and 283000, according to others. It is divided into 31 hundreds, 164 vicarages, and 660 parishes.

The air differs in different parts of the county, according to the soil, which in some parts is marshy, especially on the sea-coast, and there the air is foggy and unwholesome: in others it is clayey and chalky, poor, lean, and sandy; and there the air is good. The county is almost all champaign, except in some places,

Nonnins  
Norfolk.

Norfolk,  
North.

where rise gentle hills. The marsh-lands yield rich pasture for cattle; the clay-grounds pease, rye, and barley; and the sandy-heaths feed vast flocks of large sheep, of which some villages are said to keep 4000 or 5000. These heaths abound also in rabbits of a silver-grey colour. Wallingham is noted for producing the best saffron. Great quantities of mackerel and herring are caught upon the coasts of this county, the former in the spring, and the latter in September; especially at Yarmouth, where they are cured in a particular manner, and to great perfection. Wood and honey are also very plentiful in this shire; and on the coasts jet and ambergrease are sometimes found. The inhabitants are generally strong and active, sagacious and acute. That they are so robust, is the more to be wondered at, because the common people live much on puddings, *Norfolk dumplings*. They are for the most part in easy circumstances, and were formerly very quarrelsome and litigious. In consequence of this disposition, lawyers swarmed among them to such a degree, that a statute was made so early as the reign of Henry VI. to restrain their number. The manufactures of the county, which is exceedingly populous, are chiefly woollen and worsted stuffs, and stockings, for which they are well supplied with wool from the vast flocks of sheep bred in it. It gives title of duke to the elder branch of the family of Howard, lies in the diocese of Norwich, and sends twelve members to parliament, viz. two knights for the shire, two citizens for Norwich, and two burgesses for each of the boroughs of Lynn Regis, Great Yarmouth, Thetford, and Castle-Rising.

The county is well watered, and supplied with fish by the rivers Yare, Thyrn, Waveney, the Greater and Lesser Ouse, and the Bure, besides rivulets. The Bure abounds in excellent perch, and the Yare has a fish peculiar to it called the *ruffe*. The latter rises about the middle of the county; and after being joined by the Waveney and Bure, falls into the sea at Yarmouth. At the equinoxes, especially the autumnal, the Ouse is subject to great inundations, being forced back by the sea that enters it with great fury.

**NORFOLK**, a county of Virginia contiguous to North Carolina.

**NORMANDY**, a province of France, bounded on the north by the English channel; on the east by Picardy and the isle of France; on the south by Perche and Maine, and one part of Bretagne; and on the west by the ocean. It is about 150 miles in length, 80 in breadth, and 600 in circumference. It is one of the most fertile, and brings in the largest revenue of the kingdom. It abounds in all things except wine, but they supply that defect by cyder and perry. There are vast meadows, fat pastures, and the sea yields plenty of fish. It contains iron, copper, and a great number of rivers and harbours. It carries on a great trade, is very populous, and comprehends a vast number of towns and villages. It is divided into the Upper and Lower; the Upper borders upon Picardy, and the Lower upon Bretagne. The inhabitants are ingenious, and capable of understanding arts and sciences, but they are very fond of law. The Normans, a people of Denmark and Norway, having entered France under Rollo, Charles the Sim-

pled this country to them in 912, which from that time was called *Normandy*. Rollo was the first duke, and held it as a fief of the crown of France, and several of his successors after him, till William, the seventh duke, conquered England in 1066: from which time it became a province of England, till it was lost in the reign of king John, and re-union to the crown of France; but the English still keep the islands on the coasts of Normandy.

**NORTH** (Dudley, lord), the third baron of that accomplished family, was one of the finest gentlemen in the court of king James; but, in supporting that character, dissipated and gamed away the greatest part of his fortune. In 1645, he appears to have acted with the parliament; and was nominated by them to be administrator of the admiralty, in conjunction with the great earls of Northumberland, Essex, Warwick, and others. He lived to the age of 85, the latter part of which he passed in retirement; and wrote a small folio of miscellanies, in prose and verse, under this title, *A Forest promiscuous of several Seasons Productions*, in four parts, 1659.

**NORTH** (Dudley, lord) son of the former, was made knight of the bath in 1616, at the creation of Charles prince of Wales; and sat in many parliaments, till secluded by the prevailing party in that which condemned the king. From that period lord North lived privately in the country, and towards the end of his life entertained himself with books, and, as his numerous issue required, with economy, on which he wrote a little tract, called *Observations and advices economical*, 12mo. His other works are, *Passages relating to the long parliament*; The history of the life of the lord Edward North, the first baron of the family, addressed to his eldest son; and a volume of essays.

**NORTH** (Francis lord Guilford, lord-keeper of the great-seal in the reigns of Charles II. and James II.) was a third son of the second Dudley lord North, baron of Kertling; and studied at St John's college in Cambridge, from whence he removed to Middle Temple. He acquired French, Italian, Spanish, and Dutch; and became not only a good lawyer, but was well versed in history, mathematics, philosophy, and music. He was afterwards made the king's solicitor-general, and was chosen to represent the borough of Lynn in parliament. He succeeded Sir Heneage Finch in the post of attorney-general; and lord chief-justice Vaughan, in the place of lord chief-justice of the common-pleas. He was afterwards made keeper of the great-seal; and in 1683 was created a baron, by the title of *lord Guilford*. He died at his house at Wroxton in 1685. He wrote a philosophical essay on music; a paper on the gravitation of fluids, considered in the bladders of fishes, printed in Lowthorp's abridgment of the Philosophical Transactions; and some other pieces.

**NORTH**, one of the four cardinal points. See **Pole**.  
**NORTH-Cape**, the most northerly promontory in Europe, on the coast of Norway. E. Long. 21. o. N. Lat. 78. o.

**NORTH-Foreland**, a cape or promontory of Kent, in the isle of Thanet, four miles east of Margate. Between this and the South-Foreland are the Downs, through which all ships pass that are bound to or from the

North.



North the west. E. Long. 1. 25. N. Lat. 51. 25.

North  
Hamp-  
tonshire.

*North-West Passage*, a passage to the Pacific Ocean through Hudson's Bay or Davis's Straits, and which hath been frequently attempted without success; notwithstanding which, many people are still of opinion that it is practicable.

*North-East Passage*, a passage to the East Indies along the northern coasts of Asia, which, like the former, hath frequently been attempted, but hitherto without success. Concerning these passages an opinion hath lately been revived by the hon. Daines Barrington, namely, that they ought to be attempted by the pole itself; and he hath no doubt of the possibility of accomplishing them by that means. See *North Pole*.

**NORTHAMPTON**, a town of England, capital of a county of the same name, situated in W. Long. o. 55. N. Lat. 52. 15. According to Camden, it was formerly called *North-asandon*, from its situation to the north of the river Nen, called anciently *Aufona*, by which and another lesser river it is almost enclosed. Dr Gibbon says, that the ancient Saxon annals called both it and Southampton simply *Hamton*; and afterwards, to distinguish them, called the one, from its situation, *Southampton*, and the other *Northampton*; but never *North-asandon*. Though it does not appear to be a place of very great antiquity, yet here was a castle, and a church dedicated to St Andrew, built by Simon de Sancto Licio, commonly called *Senlez*, the first earl of Northampton of that name. It is said to have been burnt down during the Danish depredations; but in the reign of St Edward it appears to have been a considerable place. It was besieged by the barons in their war with king John; at which time that military work called *Hunsford*, is supposed to have been raised. In the time of Henry III. it sided with the barons, when it was besieged and taken by the king. Here the bloody battle was fought in which Henry VI. was taken prisoner; and several parliaments have been held in this town. It was entirely consumed by a most dreadful fire in 1675; yet, by the help of liberal contributions from all parts of the kingdom, it hath so recovered itself, that it is now one of the neatest and best-built towns of the kingdom. Among the public buildings, which are all lofty, the most remarkable are the church called *All-hallows*, the sessions and assize house, and the George inn, which belongs to the poor of the town. There was formerly a nunnery in the neighbouring meadows: A county-hospital or infirmary has been lately built here, after the manner of those of Bath, London, Bristol, &c. It has a considerable manufacture of shoes and stockings; and its fairs are noted for horses both for draught and faddle; besides, it is a great thoroughfare for the north and west roads. It gives title of *earl* to the family of Compton.

**NORTHAMPTONSHIRE**, a county of England, is situated in the very heart of the kingdom: bounded on the east by the counties of Bedford and Huntingdon; on the south by those of Buckingham and Oxford; on the west by Warwickshire; and on the north by the counties of Leicester, Rutland, and Lincoln, which are separated from it by the Lesser Avon, and the Welland. Its greatest length is about 50 miles, its greatest breadth about 20, and its circumference

about 130. It contains 33 parishes; in which are one city, 11 market-towns, and 150,000 inhabitants. Nine members are returned to parliament for this county, viz. two knights for the shire, two for the city of Peterborough, two for each of the towns of Northampton and Brockley, and one for Higham Ferrers. It lies in the Mid-land circuit, and the diocese of Peterborough. As this county is dry, well cultivated, free from marshes, except the fens about Peterborough, in the centre of the kingdom, and of course at a distance from the sea, it enjoys a very pure and wholesome air. In consequence of this it is very populous, and so full of towns and churches, that 30 spires or steeples may be seen in many places at one view; and even in the fens, the inhabitants seem to enjoy a good state of health, and to be little affected by the water which frequently overflows their grounds, especially in winter, but is never suffered to remain long upon it. Its soil is exceeding fertile both in corn and pasture; but it labours under a scarcity of fuel, as it doth not produce much wood, and, by lying at a distance from the sea, cannot be easily supplied with coal. Its commodities, besides corn, are sheep, wool, black cattle, and saltpetre; and its manufactures are serges, tammies, shalloons, boots, and shoes. Besides many lesser brooks and streams, it is well watered by the rivers Nen, Welland, Ouse, and Leam; the three first of which are large, and for the most part navigable.

**NORTHUMBERLAND**, the most northerly county of England, and formerly a distinct kingdom, is bounded on the north and west by the river Tweed, which divides it from Scotland, the Cheviot-hills, and part of Cumberland; washed on the east by the German Ocean; and separated from Durham on the south by the rivers Tyne and Derwent. This county, which gives the title of *duke* to a nobleman who married the daughter of Algernoon duke of Somerset, whose mother was heiress of the Percy family, extends about 50 miles in length from north to south, and above 40 from east to west; and is remarkably populous, containing 11 market-towns, 280 villages, and 46 parishes. The face of the country, especially towards the west, is roughened with huge mountains, the most remarkable of which are the Cheviot-hills, and the high ridge called *Ridsdale*; but the lands are level towards the sea-side and the borders of Durham. The climate, like that of every other mountainous country in the neighbourhood of the sea, is moist and disagreeable: the air, however, is pure and healthy, as being well ventilated by breezes and strong gales of wind; and in winter mitigated by the warm vapours from the two seas, the Irish and the German Ocean, between which it is situated. The soil varies in different parts of the county. Among the hills it is barren; though it affords good pasture for sheep, which cover those mountains. The low country, when properly cultivated, produces plenty of wheat, and all sorts of grain; and great part of it is laid out in meadow-lands and rich enclosures. Northumberland is well watered with many rivers, rivulets, and fountains: its greatest rivers are the Tweed and the Tyne. The Tyne is composed of two streams called *South* and *North Tyne*: the first rises on the verge of Cumberland, near Alston-moor; enters Northumber-

North um-  
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North-  
berland.

land, running north to Haltwefel; then bends easterly, and receiving the two small rivers East and West Alon, unites above Hexham with the other branch, taking its rise at a mountain called *Fano-head* in the western part of the county, thence called *Tins-dale*; is swelled in its course by the little river Sicle; joins the Read near Billingham; and running in a direct line to the south-east, is united with the southern Tyne, forming a large river that washes Newcastle, and falls into the German Ocean near Timouth.

In all probability the mountains of Northumberland contain lead-ore and other mineralized metals in their bowels, as they in all respects resemble those parts of Wales and Scotland where lead mines have been found and profecuted. Perhaps the inhabitants are diverted from inquiries of this nature, by the certain profits and constant employment they enjoy in working the coal-pits, with which this county abounds. The city of London, and the greatest part of England, are supplied with fuel from these stores of Northumberland, which are inexhaustible, enrich the proprietors, and employ an incredible number of hands and shipping.

There are no natural woods of any consequence in this county; but many plantations belonging to the seats of noblemen and gentlemen, of which here is a great number. As for pot-herbs, roots, fallading, and every article of the kitchen-garden and orchard, they are here raised in great plenty by the usual means of cultivation; as are also the fruits of more delicate flavour, such as the apricot, peach, and nectarine. The spontaneous fruits it produces in common with other parts of Great Britain, are the crab-apple, the sloe or bullace, the hazle-nut, the acorn, hips, and haws, and with the berries of the bramble, the juniper, wood-strawberries, cranberries, and bilberries.

Northumberland raises a good number of excellent horses and black cattle, and affords pasture for numerous flocks of sheep; both the cattle and sheep are of a large breed, but the wool is coarser than that which the more southern counties produce. The hills and mountains abound with a variety of game, such as red deer, foxes, hares, rabbits, heathcock, growfe, partridge, quail, plover, teal, and woodcock: indeed, this is counted one of the best sporting counties in Great Britain. The sea and rivers are well stocked with fish; especially the Tweed, in which a vast number of salmon is caught and carried to Timouth, where being pickled, they are conveyed by sea to London, and sold under the name of *Newcastle salmon*.

The Northumbrians were anciently stigmatized as a savage, barbarous people, addicted to cruelty, and inured to rapine. The truth is, before the union of the two crowns of England and Scotland, the borderers on each side were extremely licentious and ungovernable, trained up to war from their infancy, and habituated to plunder by the mutual incursions made into each kingdom; incursions which neither truce nor treaty could totally prevent. People of a pacific disposition, who proposed to earn their livelihood by agriculture, would not on any terms remain in a country exposed to the first violence of a bold and desperate enemy: therefore the lands lay uncultivated, and in a great measure deserted by every body but lawless adventu-

North-  
berland,  
Norway.

ers, who subsisted by theft and rapine. There was a tract 50 miles in length and 6 in breadth, between Berwick and Carlisle, known by the name of the *Debateable Land*, to which both nations laid claim, tho' it belonged to neither; and this was occupied by a set of banditti who plundered on each side, and what they stole in one kingdom, they fold openly in the other: nay, they were so dexterous in their occupation, that by means of hot bread applied to the horns of the cattle which they stole, they twisted them in such a manner, that, when the right owners saw them in the market, they did not know their own property. Wardens were appointed to guard the marches or borders in each kingdom; and these offices were always conferred on noblemen of the first character for influence, valour, and integrity. The English border was divided into three marches, called the *east, west, and middle marches*; the gentlemen of the country were constituted deputy-wardens, who held marsh-courts, regulated the watches, disciplined the militia, and took measures for assembling them in arms at the first alarm: but in the time of peace between the two nations, they were chiefly employed in suppressing the insolence and rapine of the borderers. Since the union of the crowns, however, Northumberland is totally changed, both with respect to the improvement of the lands, and the reformation of the inhabitants. The grounds, being now secure from incursion and insult, are settled by creditable farmers, and cultivated like other parts of the kingdom. As hostilities have long ceased, the people have forgot the use of arms, and exercised themselves in the more eligible avocations of peace; in breeding sheep and cattle, manuring the grounds, working at the coal-pits, and in different branches of commerce and manufacture. In their persons they are generally tall, strong, bold, hardy, and fresh-coloured; and though less unpolished than their ancestors, not quite so civilized as their southern neighbours. The commonalty are well fed, lodged, and clothed; and all of them remarkably distinguished by a kind of *shibboleth* or *suburle*, being a particular way of pronouncing the letter *R*, as if they hawked it up from the wind-pipe, like the cawing of rooks. In other respects, the language they speak is an uncouth mixture of the English and Scottish dialects. There is no material distinction between the fashionable people of Northumberland, and those of the same rank in other parts of the kingdom: the same form of education will produce the same effects in all countries. The gentlemen of Northumberland, however, are remarkable for their courage, hospitality, and hard drinking.

A great number of Roman monuments have been found in this county; but the most remarkable curiosity of that kind consists in the remains of *Adrian's vallum* and the wall of *Severus*. See *ADRIAN'S Wall*, and *SEVERUS'S Wall*.

The most noted towns in Northumberland, are Newcastle, Morpeth, Alnwick, Berwick, Hexham, and North Shields.

NORWAY, a country of Europe, lying between the 57th and 72d degrees of north latitude, and between the 5th and 31st degrees of longitude east from London; extending in length about 1000 miles, in a direct line from Lindesnes, in the diocese of Chri-

Chri-

Norway. Christianfand, to the North Cape, at the extremity of Finmark. Its breadth, from the frontiers of Sweden westward to Cape Statt, may amount to about 300 miles; but from thence the country becomes gradually narrower towards the north. On the south it is bounded by the Schagen-rock, or Categate, the entrance into the Baltic: on the east it is divided from Sweden by a long ridge of high mountains; and on the west and north it is washed by the northern ocean.

The coast of Norway, extending above 300 leagues, is fludded with a multitude of small islands, affording habitation to fishermen and pilots, and pasture to a few cattle. They form an infinite number of narrow channels, and a natural barrier of rocks, which renders Norway inaccessible to the naval power of its enemies. Attempts of this kind are the more dangerous, as the shore is generally bold, steep, and impending; so that close to the rocks the depth of the sea amounts to 100, 200, or 300 fathoms. The perils of the north sea are moreover increased by sudden storms, funk rocks, violent currents, and dreadful whirlpools. The most remarkable vortex on this coast is called *Moskoe-from*, from the small island Molke, belonging to the district of Lofoden in the province of Nordland. In time of flood, the stream runs up between Lofoden and Moskoe with the most boisterous rapidity; but in its ebb to the sea, it roars like a thousand cataracts, so as to be heard at the distance of many leagues. The surface exhibits different vortices; and if in one of these any ship or vessel is absorbed, it is whirled down to the bottom, and dashed in pieces against the rocks. These violent whirlpools continue without intervals, except for a quarter of an hour, at high and low water, in calm weather; for the boiling gradually returns as the flood or ebb advances. When its fury is heightened by a storm, no vessel ought to venture within a league of it. Whales have been frequently absorbed within the vortex, and howled and bellowed hideously in their fruitless endeavours to disengage themselves. A bear, in attempting to swim from Lofoden to Moskoe, was once hurried into this whirlpool, from whence he struggled in vain for deliverance, roaring so loud as to be heard on shore; but, notwithstanding all his efforts, he was borne down and destroyed. Large trees being absorbed by the current, are sucked down, and rise again all shattered into splinters. There are three vortices of the same kind near the islands of Ferroe.

Norway is divided into the four governments of Aggerhus, Bergen, Drontheim, and Wardhus, besides that of Balus, which is now subject to Sweden. The province of Aggerhus comprehends the south-east part of Norway, extending in length about 300 miles. Its chief towns are Christiania, the see of a bishop, suffragan to the metropolitan see of Drontheim, where the sovereign court of justice is held, in presence of the viceroy and the governor of the province; Aggerhus, about 15 miles to the southwest of Christiania; Frederickshall, or Frederickstadt, in the siege of which Charles XII. of Sweden lost his life; Saltzberg, Tonberg, Alleen, Hammar, and Hollen.

The government of Bergen lies in the most southerly and westerly part of Norway, including the city of the same name, which is an episcopal see, and a place

of considerable trade; and Staff-hanger, situated in the bay of Buckenfiord, about 80 miles to the southward of Bergen. The third province, called *Drontheim* or *Trontheim*, extends about 500 miles along the coast; and is but thinly peopled. The chief town Drontheim, seated on a little gulph at the mouth of the river Nider, is the only Metropolitan see in Norway; and carries on a considerable trade in malts, deals, tar, copper, and iron. Lectstrand, Stronden, Scoerdale, Opdal, Romsdael, and Solendael, are likewise places of some traffic. The northern division of Drontheim, called the *sub-government of Salten*, comprehends the towns of Melanger and Scheen. The province of Wardhus, extending to the North Cape, and including the islands, is divided into two parts; namely, Finmark and Norwegian Lapland. The chief town, which is very inconsiderable, stands upon an island, called *Ward*, from whence the place and the government derive their name. The province of Balus, though now yielded to the Swedes, is reckoned part of Norway, being a narrow track of land, about 90 miles in length, lying on the coast of the Categate.

The great chain of Norway mountains, running from north to south, called indifferently *Rudfield*, *Sudsfeld*, *Skarsfield*, and *Scoreberg*, is known in different parts by other appellations; such as *Dofrefield*, *Lamsfield*, *Sagnefield*, *Filefield*, *Halsfield*, *Hardangerfield*, *Joklefield*, *Byglefield*, *Hicklefield*, and *Hangfield*. The height and breadth of this extensive chain likewise vary in different parts. To pass the mountain Hardanger, a man must travel about 70 English miles whereas Filefield may be about 50 over. This last rises about two miles and a half in perpendicular height; but Dofrefield is counted the highest mountain of Norway, if not of Europe. The river Divance winds along the side of it in a serpentine course, so as to be met nine times by those who travel the winter-road to the other side of the chain. The bridges are thrown over roaring cataracts, and but indifferently fastened to the steep rocks on either side; so that the whole exhibits a very dreadful appearance, sufficient to deter the traveller from hazarding such a dangerous passage; for which reason, people generally choose the road over Filefield, which is much more tedious. This, however, is the post-road used by the king's carriages. The way is distinguished by posts fixed at the distance of 200 paces from each other, that, in snowy or dark weather, the traveller may not be bewildered. For the convenience of resting and refreshing, there are two mountain-houses or houles maintained on Filefield, as well as upon other mountains, at the expence of the public, and furnished with fire, light, and kitchen-utensils. Nothing can be more dismal and dreary than these mountains covered with eternal snow, where neither house, tree, nor living creature is to be seen, but here and there a solitary rein-deer, and perchance a few wandering Laplanders.

In travelling from Sweden to Nordenfields, there is only one way of avoiding this chain of mountains; and that is, where it is interrupted by a long deep valley, extending from Romsdale to Guldbrandfiel. In the year 1612, a body of 1000 Scots, commanded by Sinclair, and sent over as auxiliaries to the Swedes, were put to the sword in this defile, by the peasants of Guld-

Norway. **Guldbrand**, who never give quarter.

Besides this chain, there is a great number of detached mountains over all the country, that form valleys and ridges, inhabited by the peasants. Some of these are of incredible height, and others exhibit very remarkable appearances. In falling up Joering Creek on the left hand, the sight is astonished with a groupe of mountains, resembling the prospect of a city, with old Gothic towers and edifices. In the parish of Oerflong is the high mountain Skophorn, the top of which represents the figure of a fortification, with regular walls and bastions. In the district of Higelaaud appears a very high range of mountains, with seven pinnacles or crests, known by the appellation of the *Seven Sisters*, discernible a great way off at sea. To the southward of this range, though in the same district, rises the famous mountain *Torghatten*, so called because the summit resembles a man's head with a hat on, under which appears a single eye, formed by an aperture through the mountain, 150 ells high, and 3000 ells in length. The fun may be seen through this surprising cavity, which is passable by the foot of travellers. On the top of the mountain we find a reservoir of water, as large as a moderate fish-pond: in the lower part is a cavern, through which a line 400 fathoms in length, being let down, did not reach the bottom. At Herroe in Sundmoer is another cavern called *Dolsteen*, supposed to reach under the sea to Scotland; which, however, is no more than an idle tradition. In the year 1750, two clergymen entered this subterranean cavity, and proceeded a considerable way, until they heard the sea dashing over their heads: the passage was as wide and high as an ordinary church, the sides perpendicular, and the roof vaulted. They descended one flight of natural stairs; but arriving at another, they were afraid to penetrate farther: they had gone so far, however, that two candles were consumed in their progress and return. A cavern of a very curious nature, serving as a conduit to a stream of water, penetrates through the sides of the mountain Limur. In the district of Rake, in the neighbourhood of Frederickshall, are three cavities in a rock; one of which is so deep, that a small stone dropped down, does not reach the bottom in less than two minutes; and then the sound it produces is pleasant and melodious, not unlike the found of a bell.

The vast mountains and rugged rocks that deform the face of this country, are productive of numberless inconveniences. They admit of little arable ground: they render the country in some parts impassable, and every where difficult to travellers: they afford shelter to wild beasts, which come from their lurking holes, and make terrible havoc among the flocks of cattle: they expose the sheep and goats, as well as the peasant, to daily accidents of falling over precipices: they occasion sudden torrents, and falls of snow, which descend with incredible impetuosity, and often sweep away the labours of the husbandman; and they are subject to dreadful disruptions, by which huge rocks are rent from their sides, and, hurling down, overwhelm the plains below with inevitable ruin. The peasants frequently build their houses on the edge of a steep precipice, to which they must climb by ladders, at the hazard of their lives; and when a person dies, the corpse must be let down with ropes, before it can be

laid in the coffin. In winter the mail is often drawn up the sides of steep mountains. Even in the king's road, travellers are exposed to the frequent risks of falling over those dreadful rocks; for they are obliged to pass over narrow pathways, without rails or railing on the sides, either flored up with rotten posts, or suspended by iron bolts fastened in the mountains. In the narrow pass of Naeroe is a remarkable way of this kind, which, above 600 years ago, the famous king Surre caused to be made for the passage of his cavalry; and even this would have been found impassable by any other horses than those of Norway, which are used to climb the rocks like goats. Another very difficult and dangerous road is that between Shogstadi and Vang in Volders, along the side of a steep mountain, in some places so narrow, that if two travellers on horseback should meet in the night, they would find it impracticable either to pass each other, or turn back. In such a case their lives could not be saved, unless one of them should alight, and throw his horse headlong into the lake below, and then cling to the rock, until the other could pass. When a sheep or goat makes a false step to the projection of a rock, from whence it can neither ascend nor descend, the owner hazards his own life to preserve that of the animal. He directs himself to be lowered down from the top of the mountain, sitting on a cross stick, tied to the end of a long rope; and when he arrives at the place where the creature stands, he fastens it to the same cord, and it is drawn up with himself. Perhaps the other end of the rope is held by one person only; and there are some instances, in which the assistant has been dragged down by the weight of his friend, so that both have perished. When either man or beast has had the misfortune to fall over very high precipices, they have not only been suffocated by the repercussion of the air, but their bodies have been always burnt before they reached the ground. Sometimes entire crests of rocks, many fathoms in length and breadth, have fallen down at once, creating such a violent agitation of the air, as seemed a prelude to the world's dissolution. At Steenboom in Laerdale, a stupendous mass, larger than any castle in the universe, appears to have been severed and tumbled from the mountain in large, sharp, and ragged fragments, thro' which the river roars with hideous bellowing. In the year 1731, a promontory on Sundmoer, called *Rammersfeld*, that hung over Nordal Creek, suddenly gave way, and plunged into the water; which swelled to such a degree, that the church of Strand, thro' half a league on the other side of the bank, was overflowed: the creek, however, was not filled up; on the contrary, the fishermen declare they find no difference in the depth, which is said to exceed 900 fathoms.

The remarkable rivers of Norway are these: The Nied, issuing from Tydalen, on the borders of Sweden, runs westward into the lake Selboe; and afterwards, turning to the northward, passes by the city of Dronheim, to which it anciently gave the name of *Nideros*; and *Nidrosia*: Sule Ely, that descending from Sulefeld, runs with a rapid course thro' Nordale into the sea: Gulen, which rises near Silarsfield in the north; and running 20 leagues westward, thro' Aalen, Hlotaalen, Storee, and Melhuus, discharges itself into the sea, about a league to the west of Dronheim.

Norway. In the year 1344, this river buried itself under ground: from whence it again burst forth with such violence, that the earth and stones thrown up by the eruption, filled the valley, and formed a dam; which, however, was soon broken and washed away by the force of the water. Divers churches, 48 farm-houses, with 250 persons, were destroyed on this occasion. Otteroen, a large river, taking its rise from the mountain Agde, runs about 30 leagues through Seeterdale and Esfe, and disembogues itself into the cataract of Wiland. The river Syre rises near the mountain Lang, and winds its course thro' the vale of Syre into the lake of Lunde in the diocese of Christianfand: thence it continues its way to the sea, into which it discharges itself through a narrow strait formed by two rocks. This contraction augments its impetuosity, fo that it shoots like an arrow into the sea, in which it produces a very great agitation. Nid and Sheen are two considerable rivers, issuing out of Tillemark. Their water-falls have been diverted, with infinite labour, by canals and passages cut through the rocks, for the convenience of floating down the timber. Tyrefjord, or Dramme, is in the neighbourhood of Honifolle, joined by two rivers from Oedale and Hadeland, and disembogues itself into the sea near Bragnefs. Loven rises in the highest part of Nummedal, and runs through Konsberg to the sea near Laurwig. Glaamen is the largest river of Norway, distinguished by the name of *Stor-Elsin*, or the *great river*. It derives its origin from the mountain Dofre, from whence it winds all along the plains of Oesterdale and Soloe; then joins the Vorme, another considerable river rising out of Mioes and Guldbrandfsdale. These being joined, traverse the lake Oeyeren; and thence issuing, run on to Sarp near Frederickstad.

Norway abounds with fresh-water lakes; the principal of which are, Ryfvand in Nordland, Snaafen, Selboe, the Greater and Lesser Mioes, Slirevand, Sperrille, Rand, Vefn, Saren, Modum, Lund, Norfoe, Huidfoe, Farifvand, and Oeyevand: all these are well stocked with fish, and navigable for large vessels. Wars have been formerly carried on upon these inland seas; in some of which are small floating islands, or parcels of earth with trees on them, separated from the main land, and probably preserved in compact masses by the roots of trees, shrubs and grass, interwoven in the soil. In the year 1702, the family-seat of Borge, near Frederickstad, being a noble edifice, with lofty towers and battlements, suddenly sunk into an abyss 100 fathoms deep, which was instantaneously filled by a piece of water 300 ells in length, and about half as broad. Fourteen persons, with 200 head of cattle, perished in this catastrophe, which was occasioned by the river Glaamen precipitating itself down a water-fall near Sarp, and undermining the foundation. Of all the water-falls in Norway this of Sarp is the most dangerous for its height and rapidity. The current drives 17 mills; and roars with such violence, that the water, being dashed and comminuted among the rocks, rises in the form of rain, where a beautiful rainbow may be always seen when the sun shines. In ancient times this cataract was made use of for the execution of traitors and other malefactors: they were thrown down alive, that they might be dashed in pieces on

the points of rocks, and die in a dreadful commotion, analogous to those they had endeavoured to excite in the community.

Great part of Norway is covered with forests of wood, which constitute the principal article of commerce in this country. They chiefly consist of fir and pine, for which great sums are received from foreigners, who export an immense number of masts, beams, planks, and boards. Besides, an incredible quantity is consumed at home, in building houses, ships, bridges, piles, moles, and fences; over and above the vast demand for charcoal to the founderies, and fuel for domestic uses. Nay, in some places, the trees are felled for no other purpose but to clear the ground and to be burned into ashes for manure. A good quantity of timber is yearly exported to Scotland and Spain: but this is inconsiderable when compared to the vast exports from Drammen, Frederickshall, Frederickstad, Christiania, Skeen, Arendal, Christianfand, Christian's-bay, and Drontheim. The masts and large beams are floated down the rivers, and the rest is divided into boards at the saw-mills. These works supply a vast number of families with a comfortable subsistence. A tenth part of all sawed timber belongs to his Danish majesty, and makes a considerable branch of his revenue. The forests in Norway are so vast and thick, that the people seem to think there can never be a scarcity of wood, especially as the soil is peculiarly adapted for the production of timber: they therefore destroy it with a wasteful hand; inasmuch that more wood rots in Norway than is burned in the whole kingdom of Denmark. The best timber grows in the provinces of Saltan, Helleland, Romfsdale, Guldbrandfsdale, Oesterdale, Soloe, Valdres, Hallingdale, Sognifjord, Tellemark, and the lordship of Nedene.

The climate of Norway is very different in different parts of the kingdom. At Bergen the winter is so moderate, that the seas are always open and practicable both to mariners and fishermen, except in creeks and bays, that reach far up into the country towards Filefield, when the keen north-east wind blows from the land. On the east side of Norway from the frontiers of Sweden to Filefield, the cold generally sets in about the middle of October with great severity, and lasts till the middle of April; during which interval the waters are frozen to a very considerable thickness, and the face of the country is covered with snow. In the year 1719, 7000 Swedes, who intended to attack Drontheim, perished in the snow on the mountain of Ruden or Tydel, which separates Jemteland in Sweden from the diocese of Drontheim. A company of 200 Norwegian sledge-men under major Emahus, found them all frozen to death on the ridge of the mountain, where they had been surpris'd by a storm accompanied with snow, hail, and extreme cold. Some of these unhappy victims appeared sitting, some lying, and others kneeling in a posture of praying. They had cut in pieces their muskets, and burned the little wood they afforded. The generals Labarre and Zoega lost their lives; and of the whole corps, consisting originally of 10,000, no more than 2500 survived this dreadful catastrophe.

The cold is still more intense in that part of Norway called *Tinnark*, situated in the frigid zone near

Norway.

the polar circle. But if the winter is generally cold, the summer is often excessively hot, in Norway. The rays of the sun are reverberated from the sides of the mountains so as to render the weather clove and sultry in the valleys; besides the sun's absence below the horizon is so short, that the atmosphere and mountains have not time to cool. The heat is so great, that vegetation is remarkably quick. Barley is sown, grows, ripens, and is reaped, in the space of six weeks or two months.—The longest day at Bergen consists of 19 hours; the sun rising at half an hour after two, and setting at half an hour after nine. The shortest day does not exceed six hours; for the sun rises at nine in the morning, and sets at three in the afternoon. In the beginning of the year the daylight increases with remarkable celerity; and, at the approach of winter, decreases in the same proportion. In summer one may read and write at midnight by the light of the sky. Christian V. while he resided at Drontheim, used to sup at midnight without candles. In the district of Tromsøen, at the extremity of Norway, the sun is continually in view at midsummer. It is seen to circulate day and night round the north pole, contracting its orbit, and then gradually enlarging it, until at length it leaves the horizon. In the depth of winter, therefore, it is for some weeks invisible; and all the light perceived at noon is a faint glimmering for about an hour and an half, proceeding from the reflection of the sun's rays from the highest mountains. But the inhabitants of these provinces are supplied with other lights that enable them to follow their employments in the open air. The sky being generally serene, the moonshine is remarkably bright, and, being reflected from the mountains, illuminates the valleys. They are also afflicted by the Aurora Borealis, which is very frequent in the northern parts of Europe.

The air of Norway is generally pure and salubrious. On the sea-coasts, indeed, it is rendered moist by vapours and exhalations: but in the midland parts of the country, towards the mountains, the climate is so dry, that meal may be kept for many years without being worm eaten or damaged in the least. The inhabitants have no idea of sickness except what is occasioned by excesses. It is said that in the vale of Guldbrand the inhabitants live to such extreme old age, that they become weary of life, and cause themselves to be removed to a less salubrious climate, whereby they may have a chance of dying the sooner. In consumptions, however, the moist air on the sea-side is found to be most agreeable to the lungs in respiration. Norway, being a mountainous country intersected by creeks, abounding with lakes, rivers, and snow, must be subject to frequent rains; and from sudden thaws the inhabitants are sometimes exposed to terrible distasters. Vast masses of snow falling from precipices, overwhelm men, cattle, boats, houses, nay even whole villages. About two centuries ago, a whole parish was covered and destroyed by an immense mass of snow; and several domestic utensils, as scissars, knives, and basons, have been at different times brought to light by a rivulet that runs under the snow, which has been gradually hardened and increased by repeated frosts and annual accretions.

The winds that chiefly prevail on the western coast

Norway.

are those that blow from the south; whereas, on the other side of Filefield, the winds that produce and continue the hard frosts are always northerly. In the summer, there is a kind of regular trade-wind on the coast of Bergen. In the forenoon the sea begins to be cooled with a westerly breeze, which continues till midnight. Then the land breeze begins from the east, and blows till about ten in the morning. The coast is likewise subject to sudden squalls and storms. Hurricanes sometimes rise at sea; and in these latitudes the phenomenon called a *water-spout* is not uncommon. One of these in the neighbourhood of Ferro is said to have sucked up with the water some salts of herrings, which were afterwards dropped on Kølter, a mountain 1200 feet high.

The fresh-water of Norway is not very light or pure; but on the contrary is generally turbid, and deposits a sediment of adventitious matter, being sometimes impregnated with oker, and particles of iron. Nevertheless it is agreeable to the taste, and remarkably salubrious; as appears from the good health of the common people, who drink little or no other liquor.

The soil of Norway varies in different places according to the situation of rock or valley. The mountains here, as in every other country, are bare and barren; but the earth washed down from them by the rains, enriches and fertilizes the valleys. In these the soil generally consists of black mould, sand, loam, chalk and gravel, lying over one another in unequal strata, and sometimes in three or four successions: the mould that lies uppermost is very fine and mellow, and fit to nourish all sorts of vegetables. There is also clay found in different parts of this kingdom, of which the inhabitants begin to make earthen ware; but bricks and tiles are not used in building. The face of the country is in many places defaced by large swamps and marshes, very dangerous to the traveller. Near Leefloe in the diocese of Christiansand, a wooden causeway is extended near a mile over a morass; and if a horse or any other animal should make a false step, he will sink at once into the abyss never to rise again.

In a cold country like Norway, roughened with rocks and mountains, interspersed with bogs, and covered with forests, we cannot expect to find agriculture in perfection. The ploughed lands, in respect to mountains, woods, meadows, and wastes, do not exceed the proportion of 1 to 80; so that the whole country does not produce corn to maintain above half the number of its inhabitants. The peasants are discouraged from the practice of husbandry by the frequency of accidents that seem peculiar to the climate. Even in the fruitful provinces of Guldbrandidale, Oesterdale, and Solør, as well as in other places, when the corn appears in the most flourishing condition, the whole hope of the harvest is sometimes destroyed in one night by a sudden frost that nips the blade and extinguishes the vegetation. The kingdom is moreover visited by some unfavourable years, in which the sun seems to have lost his genial power; and the vegetables are stunted; the trees bud and bloom, yet bear no fruit; and the grain, though it rises, will yet produce nothing but empty ears and straw. This calamity, however, rarely occurs; and in general the cultivated parts of Norway yield plentiful crops of excellent

Norway. cellent rye, barley, and oats. The most fruitful provinces are Nordland, Inderbarre, and Numedale, in the diocese of Drontheim; Sognfiord, and Vaas in that of Bergen; Jedderen, Ryefylk, Raabygdela, and the lordship of Nedenes, in the diocese of Christi-anfand; Hedemark in the diocese of Aggerhuis; Hadeland, Toten, Romerige, Ringerige, and Guldbrandfale: these territories not only produce grain enough for their own consumption, but likewise support their neighbours, and even supply part of Sweden. Pease are likewise propagated in this country, together with wheat, buck-wheat, hops, hemp and flax, but not to any considerable advantage. The meadows are well sowed with pasture for sheep and cattle, and the fields are productive of those vegetables which are common in other northern countries. Within these 50 years the people of Norway have bestowed some attention on the culture of gardens, which in former times was neglected, that the cities and towns were supplied with leeks, cabbage, and roots, from England and Holland. At present, however, the Norwegians raise their own culinary and garden roots and vegetables, which thrive there as well as in any other country. The scurvy being a disease that prevails along the sea-coast, Nature has scattered upon it a variety of herbs efficacious in the cure of that distemper; such as angelica, rose-wort, gentian, cresses, trefoil, sorrel, scurvy-grass, and a plant called *erich's grass*, that grows in great plenty on the islands of Northland; from whence the people of the continent fetch away boat-loads of it, to be preserved in barrels as a succedaneum for cabbage. There are also a few noxious vegetables little known in any country but Norway. In Guldbrandfale is a species of grass called *selfsnape*; the root of which is so poisonous, that any beast which eats of it dies immediately, the belly burling; nay, the carnivorous fowls that prey upon the carcase of the beast meet with the same fate: children have been more than once poisoned by this root which nevertheless is sometimes used externally as an amulet for arthritic disorders. Another vegetable pernicious to the cattle is the *Gramen ofisifragum Norwegiensis*, which is said to mollify the bones of the cattle which feed upon it. Among the noxious plants of Norway we may also reckon the igle-grass, fatal to sheep and goats; the tour-grass, which affects horses and cows with a sort of lethargy; and the plant torboe, or hilt-fpring, which produces nearly the same effect on horses, but is not at all prejudicial to cows, sheep, or any ruminating animals. The herb turte, not unlike angelica, operates nearly in the same manner: yet the bears are said to feed upon it with peculiar relish; and when their hair begins to fall off by feeding upon this plant, they cure themselves by eating the flesh of animals.

The common fruit-trees thrive tolerably well in Norway, the inhabitants of which have plenty of cherries, apples, and pears. Some kinds of plums attain maturity; which is seldom the case with grapes, apricots, and peaches. But even the apples and pears that ripen here are summer-fruit; that which grows till the winter seldom coming to perfection. Great variety of agreeable berries are produced in different parts of this kingdom; such as the hagebar, a kind sloe; an infusion of which in wine makes a pleasant

cooling liquor; juniper-berries, corinths red and white, foelbar or fun-berries, raspberries, gooseberries, black-berries, strawberries, &c. with many other species that seem to be natives of Norway and Sweden. Among those are the tranubar, the produce of the myrtillus repens, red and austere, found in the spring in perfection under the snow, and much relished by the reindeer; crakbeer, resembling bilberries, deemed a powerful antiscorbatic; agerbeer, larger and blacker than bilberries, of a pleasant acid, ripened by cold, and used as cherries for an infusion in wine; and finally tylte-beer, a red pleasant berry growing on a short stem, with leaves like those of box: they are plucked off by handfuls, and sent to Denmark to be preserved for the table, where they are eaten by way of desert.

Of the trees that grow wild in Norway, the principal are the fir and the pine. The first yield an annual revenue of 1,000,000 of rix-dollars, if we include the advantages resulting from the saw-mills and the masts; one of which last has been known to sell for 200 rix-dollars. The red fir-tree, which grows on the mountains, is so rich in turpentine as to be almost incorruptible. Some of the houses belonging to the Norway peasants, built of this timber, are supposed to be above 400 years standing. In Guldbrandfale the house is still to be seen standing in which king Olaf lodged five nights, above 700 years ago, when he travelled round the kingdom to convert the people to the Christian faith. Even 100 years after the trunk of the fir-tree has been cut down, the peasants burn the roots for tar, which is a very profitable commodity. In the fens, the resin of the fir-tree is by nature transformed into a substance which may be called *Nature frankincense*. The buds or pine-apples of this tree, boiled in stale beer, make an excellent medicine for the scurvy; less unpleasant to the taste, though as efficacious, as tar-water. The pine-tree is more tall and beautiful than the fir, though inferior to it in strength and quality; for which reason the planks of it are sold at an inferior price, and the peasants waste it without remorse. Norway likewise produces some forests of oak, which is found to be excellent for ship-building. Here also grow plenty of elm-trees; the bark of which, being powdered, is boiled up with other food to fatten hogs, and even mixed by the poor among their meal: also the ash, from which the peasants distill a balsam used in certain disorders, and which is used both externally and internally. Many other trees flourish in this country, an enumeration of which would prove too tedious. Hazels grow here in such abundance, that 100 tons of the nuts are annually exported from Bergen alone.

A great diversity of stones is found in Norway, some of which are of a surprising figure. Several mountains consist chiefly of a brown pebble, which decays with age; nay, it sometimes dissolves, and drops into the sea, and the cement being thus loosened, a terrible disruption ensues. In some places the grey and black pebbles are intermixed with iron, copper, lead, silver, and gold. The ground, in certain districts, is covered with the fragments of rocks that have been precipitated from the summits of mountains, and broken by their fall into innumerable shivers. Between 20 and 30 years ago, in the neighbourhood of Bergen, a

Norway.

Norway.

man was suddenly overwhelmed with such a mass, which formed a kind of vault around him. In this dreadful tomb he remained alive for several weeks. By his loud cries the place of his confinement was discovered; but it was found impossible to remove the huge stones by which he was inclosed. All that his friends could do for him was, to lower down meat and drink through some crevices; but at length the stones fell in, and crushed him to death.

In Norway are inexhaustible quarries of excellent marble, black, white, blue, grey, and variegated; together with some detached pieces of alabaster, several kinds of spar, chalk-stone, cement-stone, sand-stone, mill-stone, baking-stone, slate, talc, magnets; and swine-stone, a production natural to Norway and Sweden, of a brown colour, fetid smell, in texture resembling crystal, and deriving its name from a supposed efficacy in curing a distemper incident to swine. Here also is found the amianthus or stone-flax, of which incomparable cloth may be made. Norway, however, affords no flints, but plenty of pyrites or quartz, beautiful crystals, granates, amethysts, agate, thunder-stones, and eagle-stones. Gold has formerly been found in a small quantity in the diocese of Christianland, and coined into ducats. There is at present a very considerable silver-mine wrought at Kongberg on the account and risk of his Danish majesty: the ore is surprisingly rich, but interrupted in such a manner, that the vein is often lost. Many masses of pure silver have been found; and, among the rest, one piece weighing 560 pounds, preserved in the royal museum at Copenhagen. Such is the richness of these mines, that the annual produce amounts in value to a tun and an half in gold. About 5000 people are daily employed, and earn their subsistence, in those stupendous works. Other silver-mines are prosecuted at Jarlberg, but not to the same advantage; and here the ore is mixed with lead and copper. In many parts of this country copper-mines have been discovered; but the principal, and perhaps the richest in all Europe, is at Koraa, about 100 English miles from Drontheim. This work yields annually about 1100 ship-pounds of pure copper: the founderies belonging to it consume yearly about 14,000 lasts of coal, and 500 fathoms of wood. The next in importance is the copper-work at Lykken, about 20 miles from Drontheim. A third mine is carried on at Indset, or Quickne, at the distance of 30 miles from the same place; and here they precipitate the copper from its menstruum, by means of iron. There is a fourth copper-work at Silboe, about 30 miles distant from Drontheim, though the least considerable of the four. Other copper-mines of less note are worked in different parts of the kingdom. Iron is still in greater plenty, and was the first metal wrought in this country. Many hundred thousand quintals are annually exported, chiefly in bars, and part of it in stoves, pots, kettles, and cannon: the national profit arising from this metal is estimated at 500,000 rix-dollars. There is a species called *moor-iron*, found in large lumps among the morasses: of this the peasants make their own domestic tools and utensils, such as knives, scythes, and axes. The lead found mixed in the silver ore is an article of small importance in Norway; yet some mines of this metal have been lately opened in the district of Soloe, by

Norway.

the proprietors of the copper-work at Oudal. A vitriol work has been begun near Kongberg: the mines yield great plenty of sulphur; which, however, the Norwegians will not take the trouble to melt and depurate, because immense quantities are found at a cheaper rate in the island of Iceland. Alum is found between the slate-flakes near Christiania in such plenty, that works have been set up for refining this mineral, though they have not yet brought it to any degree of transparency. His Danish majesty has established salt-works in the peninsula of Valoe, about six English miles from Tonsberg, where this mineral is extracted in large quantities from the sea-water.

Besides the animals common to other countries, Norway is said to contain many of the uncommon and dubious kind; such as the kraken, mermaid, sea-serpent, &c. See these articles.

Many Danish, English, Scotch, Dutch, and German families have settled in Norway, and now form no inconsiderable part of the trading people: but the original inhabitants are the descendants of those ferocious Normanni, who harassed almost all the coasts of Europe with piratical armaments in the 8th, 9th, and 10th centuries. They speak the same language that is used in Denmark, though their original tongue is the dialect now spoken in Iceland. They profess the Lutheran religion, under an archbishop established at Drontheim, with four suffragans; namely, of Bergen, Staffanger, Hammer, and Christiania. By the union of Calmar, the two kingdoms of Norway and Denmark were united under one monarch; and then the people of both nations enjoyed considerable privileges: but the Danish government is now become absolute; and Norway is ruled despotically by a viceroy, who resides in the capital, and presides in the supreme court, to which appeals are made from the subordinate courts of judicature.

The Norwegians are generally well-formed, tall, sturdy, and robust, brave, hardy, honest, hospitable, and ingenious: yet savage, rash, quarrelsome, and litigious. The same character will nearly suit the inhabitants of every mountainous country in the northern climates. Their women are well-shaped, tall, comely, remarkably fair and obliging. The nobility of Norway have been chiefly removed by the kings of Denmark, in order to prevent faction, and opposition to the court; or are long ago degenerated into the rank of peasants: some families, however, have been lately raised to that dignity. Every freeholder in Norway enjoys the right of primogeniture, and power of redemption; and it is very usual to see a peasant inhabiting the same house which has been possessed 400 years by his ancestors. The *odels-gods*, or freehold, cannot be alienated by sale or otherwise from the right heir, called *odels-mand*: if he is not able to redeem the estate, he declares his incapacity every 10th year at the sessions; and if he, or his heirs, to the third generation, should acquire wealth enough for that purpose, the possessor *pro tempore* must resign his possession.

The mountaineers acquire surprising strength and dexterity by hard living, cold, laborious exercise, climbing rocks, skating on the snow, and handling arms, which they carry from their youth to defend themselves against the wild beasts of the forests. Those who

dwell



Norway. dwell in the maritime parts of Norway exercise the employments of fishing and navigation, and become very expert mariners.

The peasants of Norway never employ any handicraftsmen for necessities to themselves and families: they are their own hatters, shoe-makers, tailors, tanners, weavers, carpenters, smiths, and joiners: they are even expert at ship-building; and some of them make excellent violins. But their general turn is for carving in wood, which they execute in a surprising manner with a common knife of their own forging. They are taught in their youth to wrestle, ride, swim, skate, climb, shoot, and forge iron. Their amusements consist in making verses, blowing the horn, or playing upon a kind of guitar, and the violin: this last kind of music they perform even at funerals. The Norwegians have evinced their valour and fidelity in a thousand different instances. The country was always distracted by intestine quarrels, which raged from generation to generation. Even the farmers stand upon their punctilio, and challenge one another to single combat with their knives. On such occasions they hook themselves together by their belts, and fight until one of them is killed or mortally wounded. At weddings and public feasts they drink to intoxication, quarrel, fight, and murder generally ensues. The very common people are likewise passionate, ambitious of glory and independence, and vain of their pedigree. The nobility and merchants of Norway fare sumptuously; but the peasant lives with the utmost temperance and frugality, except at festivals: his common bread is made of oat-meal, rolled into broad thin cakes, like those used in Scotland. In time of scarcity, they boil, dry, and grind the bark of the fir-tree into a kind of flour which they mix with oat-meal: the bark of the elm-tree is used in the same manner. In those parts where a fishery is carried on, they knead the roes of cod with their oat-meal. Of these last, mixed with barley-meal, they make hasty-pudding, and soup, enriched with a pickled herring or salted mackerel. Fresh fish they have in plenty on the sea-coast. They hunt and eat grouse, partridge, hare, red deer, and rein-deer. They kill cows, sheep, and goats, for their winter stock: these they pickle, or smoke, or dry for use. They make cheese of their milk, and a liquor called *fyre* of their four whey: this they commonly drink mixed with water; but they provide a store of strong ale for Christmas, weddings, christenings, and other entertainments. From their temperance and exercise, joined to the purity and elasticity of their air, they enjoy good health, and often attain to a surprising degree of longevity. Nothing is more common than to see a hearty Norwegian turned of 100. In the year 1733, four couples danced before his Danish majesty at Fredericks-hall: their ages, when joined, exceeded 800 years. Nevertheless, the Norwegians are subject to various diseases; such as the scab, the leprosy, the scurvy, the catarrh, the rheumatism, gout, and epilepsy. The dress of the Norway peasants consists of a wide loose jacket made of coarse cloth, with waistcoat and breeches of the same. Their heads are covered with flapped hats, or caps ornamented with ribbons. They wear shoes without soles, and in the winter leathern buskins. They have likewise snow-shoes and long skates, with

which they travel at a great pace, either on the land or ice. There is a corps of soldiers thus accoutred, who can out-march the swiftest horses. The Norwegian peasant never wears a neckcloth, except on extraordinary occasions: he opens his neck and breast to the weather, and lets the snow beat into his bosom. His body is girt round with a broad leathern belt, adorned with brass plates, from which depends a brass chain that sustains a large knife, gimlet, and other tackle. The women are dressed in close-laced jackets, having leathern girdles decorated with ornaments of silver. They likewise wear silver chains round their necks, to the ends of which are fixed gilt medals. Their caps and handkerchiefs are almost covered with small plates of silver, brass, and tin, large rings, and buttons. A maiden bride appears with her hair platted, and, together with her cloaths, hung full of such jingling trinkets.

The churches, public edifices, and many private houses in Norway, are built of stone: but the people in general live in wooden houses, made of the trunks of fir and pine-tree laid upon each other, and joined by mortises at the corners. These are counted more dry, warm, and healthy, than stone or brick buildings. In the whole diocese of Bergen, one hardly sees a farm-house with a chimney or windows: they are generally lighted by a square hole in the top of the house, which lets in the light, and lets out the smoke. In summer this hole is left quite open: in the winter, it is covered with what they call a *fiav*; that is, the membrane of some animal, stretched upon a wooden frame that fits the hole, and transmits the rays of light. It is fixed or removed with a long pole, occasionally. Every person that enters the house, upon business or courtship, takes hold on this pole, according to ancient custom. The ceiling is about eight feet high in the middle; and, being arched like a cupola, the smoke of the fire underneath rolls about, until it finds a vent at the hole, which is called *fiur*. Under this opening stands a thick table with benches, and an high seat at the upper end for the master of the family: he has likewise a small cupboard for his own use, in which he locks up his most valuable effects. The boards of the roof are coated with the bark of birch-trees, which is counted incorruptible: this again is covered with turf, which yields a good crop of grafs for goats and sheep, and is often mowed as hay by the farmer.

The Norwegians carry on a considerable trade with foreign nations. The duty on the produce of their own country exported, amounts annually to 100,000 rix-dollars. These commodities are, copper wrought and unwrought; iron cast into cannon, stoves, and pots, or forged into bars; lead, in small quantity; masts, timber, deal-boards, planks, marble; mill-stones, herring, cod, ling, salmon, lobsters, flounders, cow-hides, goat-skins, seal-skins, the furs of bears, wolves, foxes, beavers, ermins, martens, &c. down, feathers, butter, tallow, train-oil, tar, juniper and other sorts of berries, and nuts; salt, alum, glass, vitriol, and pot-ashes. All other commodities and articles of luxury, the Norwegians import from different nations. The nature of the ground does not admit of much improvement in agriculture: nevertheless, the farmers are not deficient in industry, and skill

Norway.

Norway,  
Norwich.

to drain marshes, and render the ground arable and fit for pasture. Many are employed in grazing and breeding cattle: but a much greater number is engaged in felling wood, floating timber, burning charcoal, and extracting tar from the roots of the trees which have been cut down; in the silver, copper, and iron mines; in the navigation and fishery. A considerable number of people earn a comfortable livelihood by hunting, shooting, and bird-catching. Every individual is at liberty to pursue the game, especially in the mountains and commons: therefore every peasant is expert in the use of fire-arms; and there are excellent marksmen among the mountains, who make use of the bow to kill those animals whose skins, being valuable, would be damaged by the shot of fire arms.

Norway can produce above 14,000 excellent fowls. The army of this country amounts to 30,000 effective men; and the annual revenue exceeds 800,000 rixdollars.

NORWAY-Rat, in zoology. See Mus.

NORWICH, the capital of the county of Norfolk in England, situated in E. Long. 1. 26. N. Lat. 52. 40. It is supposed to have had its name, which signifies "a castle to the north," from its situation in respect of Caistor, the ancient Venta Icenorum, three or four miles to the south of it, out of whose ruins it seems to have risen. In its infancy, in the reign of Etheldred, it was plundered and burnt by Sueno the Dane, when he invaded England with a great army. Afterwards it recovered; and in the reign of Edward the Confessor was a considerable place, having 1320 burghers. But it suffered again much in the reign of William I. by being the seat of a civil war, which Ralph, earl of the East Angles, raised against that king. So much was it impaired by the siege it then underwent, that there were scarce 560 burghers left in it, as appears from Doomsday-book. From that time forward it began by little and little to recover, especially after bishop Herbert translated the episcopal see hither from Thetford in the reign of William Rufus in 1096; and built a beautiful cathedral, of which he himself laid the first stone, with this inscription, *Dominus Herbertus posuit primum lapidem, in Nomine Patris, Filii, & Spiritus Sancti, Amen, i. e.* "Lord (bishop) Herbert laid the first stone, in the name of the Father, Son, and Holy Ghost;" and by a licence from pope Paschal, declared it the mother-church of Norfolk and Suffolk. After this, as Malm-bury has it, it became a town famous for merchandise and the number of inhabitants. Yet it was miserably harrassed in the reign of Henry II. by Hugh Bigod, earl of Norfolk, who was an adherent of Henry's son, called the *junior king*. In the time of Edward I. it was walled round by the citizens, who had presented a petition to Parliament for liberty to do it. Henry IV. allowed them, instead of bailiffs, which they had before, to elect a mayor yearly, and made the city a county of itself. In the year 1348, near 58 persons were carried off by the plague; and in 1507, the city was almost consumed by fire. For the flourishing state to which the city is now arrived, they are much indebted to the Flemings, who fled hither from the tyranny of the duke of Alva and the inquisition, and taught them the manufacture of those striped and flowered damasks, camblets, druggets,

Norwich.

black and white crape, for which the place is now so noted, and which have been computed to yield sometimes 160,000 l. a-year. In the year 1583, the citizens, by the help of an engine, conveyed water thro' pipes to the highest parts of the city, which is pleasantly seated along the side of a hill, extending a mile and a half in length from north to south; but the breadth is much less, and it contracts itself by degrees towards the south. It is now one of the most considerable cities in Britain for wealth, populousness, neat buildings, beautiful churches, of which it had once 50, but now about 30, and the industry and civility of the inhabitants. The cathedral is a very venerable structure, with a curious roof, adorned with the history of the Bible in little images, carved to the life, and a lofty steeple 105 yards high. The wall of flint stone, beautified with 40 towers and 12 gates, finished in 1309, is now much decayed. The city, though there is a great deal of waste ground within the walls, was computed, upwards of 40 years ago, to contain 8000 houses, and 50,000 inhabitants. Besides the cathedral already mentioned, the most remarkable buildings are, the duke of Norfolk's house, one of the largest in England; the castle, which is now the county-gaol, and stands in the heart of the city, with a deep moat round it, over which is a bridge of one very large arch; the Town-hall; the Guild-hall, formerly the church belonging to the monastery of Black-Friars; the house of correction; the shire-house, where the assizes are held; a lofty market-cross, built after the manner of a piazza; the bishop's palace; the king's school, founded by Edward VI. the boys to be nominated by the mayor for the time being, with the consent of the majority of aldermen. There having been formerly many thatched houses, an order was made, that all houses that should hereafter be built should be covered with tiles. The city is interspersed with gardens, orchards, and trees, which make it both pleasant and healthful. It has four hospitals, in which a great number of old men and women, boys and girls, are maintained; and a dozen charity-schools. Here are two churches for the Dutch and French Flemings; who have particular privileges, and are very numerous. Some of the churches are thatched, and all of them cruited with flint stone curiously cut; which is the more wonderful, as Norwich stands in a clay country, and has no flint within 20 miles of it. It is now governed by a mayor, recorder, steward, two sheriffs, 24 aldermen, 60 common-council, with a town-clerk, sword-bearer, and other inferior officers. The mayor is chosen on May-day by the freemen, and sworn in on the Tuesday before Midsummer-eve. The sheriffs are also chosen annually, on the first Tuesday in August, one by the freemen, the other by the aldermen, and sworn in on Michaelmas-day. The freemen of the several wards chuse each their alderman. The common-council is chosen in Midlent. The mayor is a justice of the peace and quorum, during his year (as are also the recorder and steward) within the city and liberties; and after his mayoralty, he is a justice during life. The trade and manufactures of the city are very considerable. At Yarmouth they export large quantities of their manufactures, most of which are sent to London, and import a great deal of wine, coal, fish, oil, &c.

Nose  
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Noftoch.

Noftoch  
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Noftre.

&c. All the city and country round are employed in the worsted manufacture, brought hither, as already observed, by the Flemings, in which they not only consume the wool of their own county, in spinning, weaving, &c. but use many thousand packs of yarn, which they receive from other parts of England, as far as Yorkshire and Westmoreland. There are eight wardens of the weavers chosen annually, and sworn to take care that there be no frauds committed in spinning, weaving, or dyeing the fluffs. It is computed that there are not less than 120,000 people employed in and about the city in the silk and woollen manufactures. Their markets are thought to be the greatest in England, and furnished with a surprising plenty and variety of goods and provisions. At a small village to the north of the city called *St Faith's*, not less than 40,000 head of Scotch cattle are said to be yearly bought up by the Norfolk graziers, and fattened in their meadows and marshes. Its markets are on Wednesday, Friday, and Saturday. It has a great number of fairs, and gives the title of earl to the duke of Norfolk.

NOSE, in anatomy; see there, n<sup>o</sup> 20, &c. The uses of the nose are, its giving us the sense of smelling \*; its serving in the great office of respiration, and in modelling voice; in receiving the abundant humours from the eyes, and in adding to the beauty of the face.

In Tartary, the greatest beauties are those who have the least noses. Ruybrock mentions the wife of the great Jenghiz Khan as a celebrated beauty, because she had only two holes for a nose. In most other countries, China excepted, great noses are in honour.

The Crim-Tartars break the noses of their children while young, as thinking it a great piece of folly to have their noses stand before their eyes.

NOSOLOGY, in medicine. See p. 4631—4643.

NOSTOCH, the name of a vegetable substance which seems to differ from most of the other bodies of that kind in several particulars. It is a substance of an irregular figure, of a greenish brown colour, and somewhat transparent. It trembles at the touch, in the manner of a jelly; but it does not melt when held in the hand. It has therefore somewhat of the characters of a vegetable leaf, but it has neither veins nor fibres. It is found in all sorts of soils; but most frequently in sandy ones, sometimes on the gravel of garden walks, and most usually makes its appearance after rain. It is found only in the summer-months; and retains its humidity and perfect figure as long as it is a moist season, but immediately dries up and withers away on the sun or the wind's affecting it. Many people have supposed this not to be a plant. It appears all on a sudden, and, as it were, by a sort of miracle, either from the earth or clouds; and some have called it *flower of earth*, others *flower of heaven*; and the obscurity of its origin occasioned its being held in great esteem among the chemists; some of whom supposed it to contain an universal spirit, capable of converting other metals into gold. Mr Mag-nol and Mr Tournefort were the first authors who asserted its true origin, and ranged it among the plants. Its nature, however, was never perfectly discovered till Mr Reaumur took it under consideration. He found

that it was a leaf which naturally imbibed water in a very particular manner; that when it had enough of this liquor in it, it then appeared in its natural flourishing state; and when it lost this again, it became thin, wrinkled, and was not to be known for the same substance, or, indeed, scarce to be seen at all. Hence appears the reason of its supposed production and sudden decay. If it has, ever so long, lain in the walks of a garden in its empty wrinkled state, it is never taken notice of; but, on a shower of rain, it swells out into its jelly-like state, and on the sun's evaporating that moisture it falls into its undistinguishable state again; and these changes may affect the same plant alternately for many days together.

Mr Geoffroy imagined that he had found roots to the noftoch; but Mr Reaumur positively asserts that it has none. He observed indeed, at certain times, on the surface of certain specimens of this, a vast number of round tubercles of different sizes, which appeared to be the seeds of the plant. These he regularly sowed in earthen pots of mould; and these produced young plants like the parent noftoch: But even these were never discovered to have any appearance of roots; and to try farther whether they had any, Mr Reaumur turned all the plants bottom upwards, and they received no harm from it, but grew just as vigorously as before. If the noftoch has truly no roots, as appears to be very evidently the case, it follows, that it imbibes its nourishment in the manner of sea-plants, which imbibe the water at all their pores. It should seem, that there are two species of this noftoch: the one a plain, flat, leaf; the other curled, wrinkled, and variously undulated: and it is on this last that the fruits which produce the young plants are principally found. It may be, however, that the one of these may be the male and the other the female of the same species, as in many large plants; or possibly the being in the state of fructification alone may make the difference.

NOSTRADAMUS (Michael), an able physician and famous astrologer, born at St Remy, a small town, four leagues from Arles, in 1503. He studied at Montpellier, and afterwards travelled to Toulouse and Bourdeaux. At his return into Provence, he published, in 1555, his *Seven first propheticall centuries*. These were so highly valued by the French king, Henry II. that he relolved to see the author; and having caused him to be brought to him, gave him 200 golden crowns, and sent him to see the princes his sons at Blois. Charles IX. in passing through Provence, also gave him public marks of his esteem. Nostradamus published his three last Centuries in 1556; and died at Salon in 1566. He wrote other works, and after his death was collected an 11th and 12th Century from his writings. The following dillich, attributed to Stephen Judelle, on Nostradamus's character, is well known.

*Nostra damus, cum falsa damus, nam fallere nostrum est:  
Et cum falsa damus, nil nisi Nostra damus.*

NOSTRE (Andrew le), comptroller of the buildings of the French king, and designer of his gardens, distinguished himself by carrying the art of laying out gardens to great perfection. He was born at Paris in 1631; and was near 40 years of age when M. Fouquet superintendent of the finances gave him

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\* See  
*Anatomy*,  
n<sup>o</sup> 404.

Notary  
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Notitia.

an opportunity of becoming known by the fine gardens of Vaux-le-Vicomte. He was afterwards employed by Lewis XIV. at Versailles, Triannon, St Germain, &c. and discovered an admirable taste in all his works. In 1678 he went to Rome, with the permission of the French king, to improve his skill; but he found nothing there comparable to what he himself had done. Pope Innocent XI. resolved to see Le Noître, and gave him a pretty long audience; at the conclusion of which Le Noître said, "I have seen the two greatest men in the world; your holiness, and the king my master." There is a great difference, answered the pope: "The king is a great victorious prince; and I am a poor priest, the servant of the servants of God." Le Noître, charmed with this answer, and forgetting who he was with, clapped the pope on the shoulder, saying, "Reverend father, you look extremely well, and will live to bury all the sacred college." The pope laughed at his prediction. Le Noître, charmed more and more at the goodness of the sovereign pontiff, and the singular effect he shewed for the king, threw his arms about the pope's neck and kissed him. It was his custom to behave in the same manner to all who spoke in praise of Lewis XIV. and he even embraced the king himself whenever that prince returned from the country. Le Noître had also a talent for painting. He preserved his good sense and vivacity of mind to the end of his life; and died at Paris in 1700, aged 87.

NOTARY, (NOTARIUS), signifies a person, usually some scrivener, who takes notes, or frames short draughts, of contracts, obligations, charter-parties, or other writings. At present we call him a *notary-public*, who publicly attests deeds, or writings, in order to make them authentic in another nation: but he is principally employed in business concerning merchants; as making protests of bills of exchange, &c. And noting a bill, is where he goes to take notice of a merchant's refusal to accept or pay the same.

NOTATION, in arithmetic and algebra, the method of expressing numbers or quantities by signs or characters appropriated for that purpose. See ARITHMETIC and ALGEBRA.

NOTES, in music, characters which mark the sounds, *i. e.* the elevations and fallings of the voice, and the swiftness and slowness of its motions.

NOTE is likewise used for a mark made in a book or writing, where there occurs something remarkable and worthy of particular notice: as also for an observation or explication of some passage in an author added in the margin, at the bottom of the page, or elsewhere; in which sense it stands contradistinguished to *text*.

NOTE, is also a minute, or short writing, containing some article of business; in which sense we say, promissory note, note of hand, bank-note, &c.

NOTHUS, signifies *spurious*, or *bastard*; whence it is figuratively applied by physicians to such diseases as, though in a respect of a similitude of symptoms, &c. they have the same denomination as some others, yet are of a different origin, seat, or the like, from the same.

NOTION, in logic, an idea or representation of any thing in the mind. See LOGIC and METAPHYSICS.

NOTITIA, in literary history, a book that gives

an account of a particular country, city, or other place: such is the *Notitia Imperii Romani*, *Notitia Rome Antiqua*, &c.

Nota,  
Notonecta.

NOTO, an ancient, large, and handsome town of Sicily, and capital of the Val-di-Noto. It was entirely ruined by an earthquake in 1693; but the inhabitants built another town at some distance from it, which they call *Noto Nuovo*. E. Long. 14. O. N. Lat. 36. 50.

Notro (*Val-di*), one of the three valleys or provinces into which Sicily is divided; and it lies between the sea, Val-di-Demona, and Val-di-Mazara. Noto is the capital town.

NOTONECTA, the BOAT-FLY; a genus of insects belonging to the order of hemiptera. It generally inhabits the water, and always swims on its back, and is very swift in its motions. Its belly, which it shews while in the water, is of a yellowish white; its legs are long; when taken out of the water, it hops. It is indeed a very beautiful and very nimble little creature; and is common in the ponds of water in Hyde-park, and in several other places about London. It has four wings, six legs, and no antennæ; it is eight inches long, three broad, and two and a half thick. The body is black, and of a very particular form, being flattish at the belly, and rising to a ridge on the middle of the back; so that when it swims, which is almost always on the back, its body resembles a boat in figure.

The belly is jointed, striated, and hairy; and has a large opening at the tail, out of which, when hurt, it thrusts forth something resembling a sting. The head and shoulders are large, hard, and yellow, without any spots; the eyes are large and red, and of a somewhat triangular form. The nose is a long, green, hollow proboscis, terminating in a hard and sharp brown point; this, in its natural posture, is kept under the belly, and reaches to the middle pair of legs. The outer pair of wings are of a pale flesh-colour, with spots of a dead white; these are long, narrow, and somewhat transparent: they terminate in a roundish point, and perfectly cover the whole body. The triangular piece which stands between the top of the wings is hard, and perfectly black; the inner wings are broader and shorter than the outer ones; they are thin and perfectly transparent, and are of a pale pearl colour. The legs are green and hairy; the foremost pair are shortest; the middle ones longer than these; but the hinder pair are greatly longer than all the rest, so that they serve as oars, and are tufted with hair at the end to that purpose. This creature mostly lives in the water, where it preys on small insects, killing them and sucking their juices with its proboscis, in the manner of the water-scorpion and many other aquatic insects; and it seizes its prey violently, and darts with incredible swiftness to a considerable distance after it.

Though it generally lives in the water, it sometimes, however, crawls out in good weather; and drying its wings by expanding them in the sun, takes flight, and becomes an inhabitant of the air, not to be known for the same creature, unless to those who had accurately observed it before; when tired of flying, or in danger of an enemy, it immediately plunges into the water. If taken into the hand, it stings, and gives

Notting-  
hamshire  
Novatio.

Notteberg, gives an intolerable pain, but this goes off in a very few minutes. This is the species most frequently met with; but it is not the only *notacea* we have, three or four other kinds, different in size and colour, being found not unfrequently in large waters.

**NOTEBURG**, a town of Russia, in the province of Ingria, seated on an island in the lake Ladoga, at the place where the river Nieva proceeds from this lake. It is strong, has a good citadel, and was capital of the province before Peterburg was built. E. Long. 31. 40. N. Lat. 60. 0.

**NOTTINGHAMSHIRE**, a county of England, bounded on the east by Lincolnshire, on the south-east and south by Leicestershire, on the west by Derbyshire, and on the north and north-west by Yorkshire. It extends in length 43 miles, 24 in breadth, and 110 miles in compass; containing 560,000 acres, 8 hundreds, 9 market-towns, 168 parishes, 450 villages, about 175,000 houses, and 95,000 inhabitants. No county in England enjoys a pleasanter and healthier air. As for the soil, it differs widely in different parts of the county. Towards the west, where lies the forest of Sherwood, it is sandy; and therefore that part of the county is called by the inhabitants, the *Sand*: but the south and east parts, watered by the Trent and the rivulets that fall into it, are clayey; and for that reason are called by the inhabitants, the *Clay*. The latter is fruitful both in corn and pasture; but the former produces little besides wood, coal, and some lead. The county has a variety of commodities and manufactures, as wool, leather, tallow, butter, cheese, coal, marble, cattle, malt, liquorice, stockings, glass, earthen-ware, and strong ale. The principal rivers are the Trent and Idle. The Trent, whose name is supposed to be derived from the French or Latin word signifying *thirty*, either because it receives thirty smaller rivers, or has thirty different sorts of fish in it, is inferior to no river in England, but the Severn, Thames, and Humber. It enters the county on the south-west, and passes through it to the north-east, where it enters Lincolnshire, and after a long course falls at last into the Humber. The Idle rises in Sherwood-forest; and after traversing the northern part of the county, falls into the Trent upon the borders of Yorkshire and Lincolnshire.

The spacious forest of Sherwood lies in the west part of the county, and indeed takes up the greatest part of it. It was formerly so thick, that it was hardly passable; but now it is much thinner. It feeds an infinite number of deer and stags; and has some towns in it, of which Mansfield is the chief. It abounds in coal, and a road lies through it for thirty miles together. Since the reign of king Edward I. the nobility and gentry have had grants of it. It is governed by a great number of officers under the earl of Chesterfield, chief forester; whose ancestor, Sir John Stanhope, had a grant of it, with liberty to destroy and kill at pleasure, reserving only an hundred deer in the whole walk. The principal town is

**NOTTINGHAM**, which gives name to the county. It is a handsome town, and a county of itself by charter. The name is derived from the Saxon word *Snottengham*, which signifies caves, from the caves and apartments anciently dug in the rocks on which the town stands. These, being soft, easily yield to the spade and pick-

axe; whence the townmen have excellent cellars for the vast quantities of malt liquors made here, and sent, as well as their malt, to most parts of England. The situation of the town is very pleasant, having meadows on one hand, and hills of a gentle, easy ascent, on the other. It is well supplied with fuel, both wood and coal, from the forest; and with fish by the Trent, which runs about a mile to the south of it, and has been made navigable for barges: so that they receive by it not only great quantities of cheese from Warwickshire and Staffordshire; but all their heavy goods from the Humber, and even from Hull. It is of great antiquity; and had anciently a very strong castle, where is now a fine feat belonging to the duke of Newcastle. It is noted for its horse-races on a fine course on the north side of the town. The corporation is governed by a mayor, recorder, six aldermen, two coroners, two sheriffs, two chamberlains, and twenty-four common-council men, eighteen of the senior-council, and six of the junior, a bell-bearer, and two pinders, one for the fields, and the other for the meadows. The town being within the jurisdiction of the forest, the former of these pinders is town-wardward, and attends the forest courts. It has three neat churches, the chief of which is St Mary's; and an alm-house, endowed with 100 l. a-year, for twelve poor people; with a noble town-house, surrounded with piazzas. A considerable trade is carried on in glass and earthen-ware, and frame-stockings, besides the malt, and malt-liquors, mentioned above. Marshal Tallard, when a prisoner in England, was confined to this town and county. In the duke of Newcastle's park there is a ledge of rocks hewn into a church, houses, chambers, dove-houses, &c. The altar of the church is natural rock, and between that and the castle there is an hermitage of the like workmanship. Upon the side of a hill there is a very extraordinary sort of a house, where you enter at the garret, and ascend to the cellar, which is at the top of the house. Here is a noted hospital founded by John Plumtree, Esq; in the reign of Richard II. for thirteen poor old widows. There are four handsome bridges over the Trent and Lind. To keep these in repair, and other uses, the corporation has good estates. This town and Winchelsea both give title of earl to the noble family of Finch. Here David, king of Scots, when a prisoner in England, resided; and under-ground in a vault, called *Mortimer's hole*, because Roger Mortimer, earl of March, is said to have absconded in it, when he was taken and hanged by order of Edward III.

**NOVA-SCOTIA**. See *NOVA-SCOTIA*.

**NOVA Zembla**. See *NOVA ZEMBLA*.

**NOVALLE**, a small, rich, and populous town of Italy, between Padus and Treviso. E. Long. 12. 5. N. Lat. 45. 35.

**NOVARA**, an ancient, well built, and strong town of Italy, in the duchy of Milan, and capital of the Novarese, with a bishop's see; seated upon an eminence. E. Long. 8. 35. N. Lat. 45. 25.

**NOVATIANS**, a Christian sect which sprung up in the third century, so called from Novatian a priest of Rome, or Novatus. See *NOVATUS*.

**NOVATION**, or *INNOVATION*, in the civil law, denotes the change of one kind of obligation for another;

Novatus ther; as when a promise is accepted instead of a written obligation.

Novelty.

NOVATUS, a priest of Carthage, in the third century, who, to avoid being punished for a crime, joined with the deacon, named *Felicissimus*, against St Cyrian. He went to Rome in 251; and there found Novatian, a priest who had acquired great reputation by his eloquence; but who murmured at his not being raised to the see of Rome in preference to pope Cornelius. Novatus contracted a friendship with him; and afterwards, it is said, getting three ignorant bishops, made them drunk, and then obliged them to ordain Novatian bishop of Rome. This irregular ordination produced a very great schism; both Novatus and Novatian maintained, that the church had not the power to receive those to communion who were fallen into idolatry. There are attributed to Novatian, the treatise on the Trinity, and the book on Jewish meats, which are among Tertullian's works; and it was he, and not Novatus, who gave his name to the sect called *Novatians*.

NOVEL, in matters of literature, a fictitious history of a series of entertaining events in common life, wherein the rules of probability are, or ought to be, strictly preserved.

NOVEL, in the civil law, a term used for the constitutions of several emperors, more particularly those of Justinian. They were called *novels*, either from their producing a great alteration in the face of the ancient law, or because they were made on new cases, and after the revival of the ancient code.

NOVELTY, or NEWNESS. Of all the circumstances that raise emotions, not excepting beauty, nor even greatness, says Lord Kames †, novelty hath the most powerful influence. A new object produceth instantaneously an emotion termed *wonder*, which totally occupies the mind, and for a time excludes all other objects. Conversation among the vulgar never is more interesting than when it turns upon strange objects and extraordinary events. Men tear themselves from their native country in search of things rare and new; and novelty converts into a pleasure, the fatigues and even perils of travelling. To what cause shall we ascribe these singular appearances? To curiosity undoubtedly; a principle implanted in human nature for a purpose extremely beneficial, that of acquiring knowledge; and the emotion of wonder raised by new and strange objects, inflames our curiosity to know more of such objects. This emotion is different from *admiration*: novelty, wherever found, whether in a quality or action, is the cause of wonder; admiration is directed to the person who performs any thing wonderful.

During infancy, every new object is probably the occasion of wonder, in some degree; because, during infancy, every object at first sight is strange as well as new: but as objects are rendered familiar by custom, we cease by degrees to wonder at new appearances, if they have any resemblance to what we are acquainted with; for a thing must be singular as well as new, to raise our wonder. To save multiplying words, we would be understood to comprehend both circumstances when we hereafter talk of novelty.

In an ordinary train of perceptions where one thing

introduces another, not a single object makes its appearance unexpectedly †: the mind thus prepared for the reception of its objects, admits them one after another without perturbation. But when a thing breaks in unexpectedly, and without the preparation of any connection, it raises an emotion, known by the name of *surprise*. That emotion may be produced by the most familiar object, as when one unexpectedly meets a friend who was reported to be dead; or a man in high life, lately a beggar. On the other hand, a new object, however strange, will not produce the emotion, if the spectator be prepared for the sight: an elephant in India will not surprise a traveller who goes to see one; and yet its novelty will raise his wonder: an Indian in Britain would be much surprised to stumble upon an elephant feeding at large in the open fields; but the creature itself, to which he was accustomed, would not raise his wonder.

Surprise thus in several respects differs from wonder: unexpectedness is the cause of the former emotion; novelty is the cause of the latter. Nor differ they less in their nature and circumstances, as will be explained by and by. With relation to one circumstance they perfectly agree; which is, the shortness of their duration: the instantaneous production of these emotions in perfection, may contribute to that effect, in conformity to a general law, That things soon decay which soon come to perfection: the violence of the emotions may also contribute; for an ardent emotion, which is not susceptible of increase, cannot have a long course. But their short duration is occasioned chiefly by that of their causes: we are soon reconciled to an object, however unexpected; and novelty soon degenerates into familiarity.

Whether these emotions be pleasant or painful, is not a clear point. It may appear strange, that our own feelings and their capital qualities, should afford any matter for a doubt: but when we are engrossed by any emotion, there is no place for speculation; and when sufficiently calm for speculation, it is not easy to recal the emotion with accuracy. New objects are sometimes terrible, sometimes delightful: the terror which a tyger inspires is greatest at first, and wears off gradually by familiarity: on the other hand, even women will acknowledge that it is novelty which pleases the most in a new fashion. It would be rash however to conclude, that wonder is itself neither pleasant nor painful, but that it assumes either quality according to circumstances. An object, it is true, that hath a threatening appearance, adds to our terror by its novelty: but from that experiment it doth not follow, that novelty is in itself disagreeable; for it is perfectly consistent, that we be delighted with an object in one view, and terrified with it in another. A river in flood swelling over its banks, is a grand and delightful object; and yet it may produce no small degree of fear when we attempt to cross it: courage and magnanimity are agreeable; and yet, when we view these qualities in an enemy, they serve to increase our terror. In the same manner, novelty may produce two effects clearly distinguishable from each other: it may, directly and in itself, be agreeable; and it may have an opposite effect indirectly, which is, to inspire terror; for when a new object appears in any degree dangerous,

Novelty. † See the article PERCEPTIONS.

† Elem. of Criticism.

ous, our ignorance of its powers and faculties affords ample scope for the imagination to dress it in the most frightful colours. The first sight of a lion, for example, may at the same instant produce two opposite feelings, the pleasant emotion of wonder, and the painful passion of terror: the novelty of the object produces the former directly, and contributes to the latter indirectly. Thus when the subject is analysed, we find, that the power which novelty hath indirectly to inflame terror, is perfectly consistent with its being in every circumstance agreeable. The matter may be put in the clearest light, by adding the following circumstances. If a lion be first seen from a place of safety, the spectacle is altogether agreeable without the least mixture of terror. If, again, the first sight puts us within reach of that dangerous animal, our terror may be so great as quite to exclude any sense of novelty. But this fact proves not that wonder is painful: it proves only, that wonder may be excluded by a more powerful passion. Every man may be made certain from his own experience, that wonder raised by a new object that is inoffensive, is always pleasant; and with respect to offensive objects, it appears, from the foregoing deduction, that the same must hold as long as the spectator can attend to the novelty.

Whether surprise be in itself pleasant and painful, is a question not less intricate than the former. It is certain that surprise inflames our joy when unexpectedly we meet with an old friend; and not less our terror when we stumble upon any thing noxious. To clear that question, the first thing to be remarked is, that in some instances an unexpected object overpowers the mind, so as to produce a momentary stupefaction: where the object is dangerous, or appears so, the sudden alarm it gives, without preparation, is apt totally to unhinge the mind, and for a moment to suspend all its faculties, even thought itself; in which state a man is quite helpless; and if he move at all, is as like to run upon the danger as from it. Surprise carried to such a height, cannot be either pleasant or painful; because the mind, during such momentary stupefaction, is in a good measure, if not totally, insensible.

If we then inquire for the character of this emotion, it must be where the unexpected object or event produceth less violent effects. And while the mind remains sensible of pleasure and pain, is it not natural to

suppose, that surprize, like wonder, should have an invariable character? It would appear, however, that surprize has no invariable character, but assumes that of the object which raises it. Wonder being an emotion invariably raised by novelty, and being distinguishable from all other emotions, ought naturally to possess one constant character. The unexpected appearance of an object, seems not equally intitled to produce an emotion distinguishable from the emotion, pleasant or painful, that is produced by the object in its ordinary appearance: the effect it ought naturally to have, is only to swell that emotion, by making it more pleasant or more painful than it commonly is. And that conjecture is confirmed by experience, as well as by language which is built upon experience: when a man meets a friend unexpectedly, he is said to be agreeably surprized; and when he meets an enemy unexpectedly, he is said to be disagreeably surprized. It appears, then, that the sole effect of surprize is to swell the emotion raised by the object. And that effect can be clearly explained: a tide of connected perceptions glide gently into the mind, and produce no perturbation; but an object breaking in unexpectedly, sounds an alarm, rouses the mind out of its calm state, and directs its whole attention to the object, which, if agreeable, becomes doubly so. Several circumstances concur to produce that effect: on the one hand, the agitation of the mind and its keen attention, prepare it in the most effectual manner for receiving a deep impression: on the other hand, the object, by its sudden and unforeseen appearance, makes an impression, not gradually as expected objects do, but as at one stroke with its whole force. The circumstances are precisely similar where the object is in itself disagreeable (A).

The pleasure of novelty is easily distinguished from that of variety: to produce the latter, a plurality of objects is necessary; the former arises from a circumstance found in a single object. Again, where objects, whether coexistent or in succession, are sufficiently diversified, the pleasure of variety is complete, though every single object of the train be familiar; but the pleasure of novelty, directly opposite to familiarity, requires no diversification.

There are different degrees of novelty, and its effects are in proportion. The lowest degree is found in objects surveyed a second time after a long interval; and that in this case an object takes on some appearance

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(A) What the Marechal Saxe terms *le cœur humain*, is no other than fear occasioned by surprize. It is owing to that cause that an ambush is generally so destructive: intelligence of it beforehand renders it perfectly harmless. The Marechal gives from Cæsar's Commentaries two examples of what he calls *le cœur humain*. At the siege of Amiens by the Gauls, Cæsar came up with his army, which did not exceed 7000 men; and began to intrench himself in such hurry, that the barbarians, judging him to be afraid, attacked his intrenchments with great spirit. During the time they were filling up the ditch, he issued out with his cohorts, and by attacking them unexpectedly struck a panic that made them fly with precipitation, not a single man offering to make a stand. At the siege of Alesia, the Gauls infinitely superior in number attacked the Roman lines of circumvallation, in order to raise the siege. Cæsar ordered a body of his men to march out silently, and to attack them on the one flank, while he with another body did the same on the other flank. The surprize of being attacked when they expected a defence only, put the Gauls into disorder, and gave an easy victory to Cæsar.

A third may be added not less memorable. In the year 846, an obstinate battle was fought between Xamire king of Leon, and Abdoulrahman the Moorish king of Spain. After a very long conflict, the night only prevented the Arabians from obtaining a complete victory. The king of Leon, taking advantage of the darkness, retreated to a neighbouring hill, leaving the Arabians masters of the field of battle. Next morning, perceiving that he could not maintain his place for want of provisions, nor be able to draw off his men in the face of a victorious army, he ranged his men in order of battle, and, without losing a moment, marched to attack the enemy, resolving to conquer or die. The Arabians, astonished to be attacked by those who were conquered the night before, lost all heart: fear succeeded to astonishment, the panic was universal, and they all turned their backs without almost drawing a sword.

Novelty.

ance of novelty, is certain from experience: a large building of many parts variously adorned, or an extensive field embellished with trees, lakes, temples, statues, and other ornaments, will appear new oftener than once: the memory of an object so complex is soon lost, of its parts at least, or of their arrangement. But experience teaches, that, even without any decay of remembrance, abience alone will give an air of novelty to a once familiar object; which is not surprising, because familiarity wears off gradually by abience: thus a person with whom we have been intimate, returning after a long interval, appears like a new acquaintance. And distance of place contributes to this appearance, not less than distance of time: a friend, for example, after a short absence in a remote country, has the same air of novelty as if he had returned after a longer interval from a place nearer home: the mind forms a connection between him and the remote country, and bestows upon him the singularity of the objects he has seen. For the same reason, when two things equally new and singular are presented, the spectator balances between them; but when told that one of them is the product of a distant quarter of the world, he no longer hesitates, but clings to it as the more singular: hence the preference given to foreign luxuries, and to foreign curiosities, which appear rare in proportion to their original distance.

The next degree of novelty, mounting upward, is found in objects of which we have more information at second hand; for description, though it contribute to familiarity, cannot altogether remove the appearance of novelty when the object itself is presented: the first sight of a lion occasions some wonder, after a thorough acquaintance with the correctest pictures and statues of that animal.

A new object that bears some distant resemblance to a known species, is an instance of a third degree of novelty: a strong resemblance among individuals of the same species, prevents almost entirely the effect of novelty, unless distance of place or some other circumstance concur; but where the resemblance is faint, some degree of wonder is felt, and the emotion rises in proportion to the faintness of the resemblance.

The highest degree of wonder arises from unknown objects that have no analogy to any species we are acquainted with. Shakspeare in a simile introduces that species of novelty:

As glorious to the sight  
As is a winged messenger from heaven  
Unto the white up-tuned wond'ring eye  
Of mortals, that fall back to gaze on him  
When he bestrides the lazy-pacing clouds  
And sails upon the bosom of the air.

*Romeo and Juliet.*

One example of that species of novelty deserves peculiar attention; and that is, when an object altogether new is seen by one person only, and but once. These circumstances heighten remarkably the emotion: the singularity of the spectator concurs with the singularity of the object, to inflame wonder to its highest pitch.

In explaining the effects of novelty, the place a being occupies in the scale of existence, is a circumstance that must not be omitted. Novelty in the individuals of a low class is perceived with indifference, or with a very slight emotion: thus a pebble, however singular

in its appearance, scarce moves our wonder. The emotion rises with the rank of the object; and, other circumstances being equal, is strongest in the highest order of existence; a strange insect affects us more than a strange vegetable; and a strange quadruped more than a strange insect.

However natural novelty may be, it is a matter of experience, that those who relish it the most are careful to conceal its influence. Love of novelty, it is true, prevails in children, in idlers, and in men of shallow understanding; and yet, after all, why should one be ashamed of indulging a natural propensity? A distinction will afford a satisfactory answer. No man is ashamed of curiosity when it is indulged to acquire knowledge. But to prefer any thing merely because it is new, shows a mean taste which one ought to be ashamed of: vanity is commonly at the bottom, which leads those who are deficient in taste to prefer things odd, rare, or singular, in order to distinguish themselves from others. And in fact, that appetite, as above-mentioned, reigns chiefly among persons of a mean taste, who are ignorant of refined and elegant pleasures.

One final cause of wonder, hinted above, is, that this emotion is intended to stimulate our curiosity. Another, somewhat different, is, to prepare the mind for receiving deep impressions of new objects. An acquaintance with the various things that may affect us, and with their properties, is essential to our well-being: nor will a slight or superficial acquaintance be sufficient; they ought to be so deeply engraved on the mind, as to be ready for use upon every occasion. Now, in order to a deep impression, it is wisely contrived, that things should be introduced to our acquaintance with a certain pomp and solemnity productive of a vivid emotion. When the impression is once fairly made, the emotion of novelty being no longer necessary, vanishes almost instantaneously; never to return, unless where the impression happens to be obliterated by length of time or other means, in which case the second introduction hath nearly the same solemnity with the first.

Delighting wisdom is no where more eligible than in this part of the human frame. If new objects did not affect us in a very peculiar manner, their impressions would be so slight as scarce to be of any use in life: on the other hand, did objects continue to affect us as deeply as at first, the mind would be totally engrossed with them, and have no room left either for action or reflection.

The final cause of surprise is still more evident than of novelty. Self-love makes us vigilantly attentive to self-preservation; but self-love, which operates by means of reason and reflection, and impels not the mind to any particular object or from it, is a principle too cool for a sudden emergency; an object breaking in unexpectedly, affords no time for deliberation; and in that case, the agitation of surprise comes in seasonably to rouse self-love into action: surprise gives the alarm; and if there be any appearance of danger, our whole force is instantly summoned to slun or to prevent it.

NOVELLARA, a handsome town of Italy, and capital of a small district of the same name, with a handsome castle, where their sovereign resides. E. Lon.

Novelty,  
Novellara.



Novemviri 10. 37. N. Lat. 45. 50.

**NOVEMVIRI**, nine magistrates of Athens, whose government lasted but for one year. The first of whom was called *archon*, or prince; the second *basillus*, or king; the third *polemarchus*, or general of the army; the other fix were called *thesmothete*, or lawgivers. They took an oath to observe the laws; and in case of failure, obliged themselves to bestow upon the commonwealth a statue of gold as big as themselves. Those who discharged their office with honour, were received into the number of the senators of *Areopagus*.

**NOVI**, a town of Italy, in the territory of Genoa, on the confines of the Milanese. It was taken by the Piedmontese in 1746. E. Long. 8. 48. N. Lat. 44. 45.

**NOVI-BAZAR**, a considerable town of Turkey in Europe, and in Serbia, near the river *Orefco*. E. Long. 20. 24. N. Lat. 43. 25.

**NOVIGRAD**, a small but strong town of Upper Hungary, capital of a county of the same name, with a good castle, seated on a mountain near the Danube. E. Long. 18. 10. N. Lat. 47. 50.

**NOVIGRAD**, a small but strong town of Dalmatia, with a castle, and subject to the Turks; seated on a lake of the same name, near the gulph of Venice. E. Long. 16. 45. N. Lat. 44. 30.

**NOVIGRAD**, a very strong place of Serbia, subject to the Turks; seated near the Danube. E. Long. 26. 5. N. Lat. 45. 5.

**NOVICE**, a person not yet skilled or experienced in an art or profession.

In the ancient Roman militia, *novicii*, or *novitii*, were the young raw soldiers, distinguished by this appellation from the veterans.

In the ancient orders of knighthood, there were novices, or clerks in arms, who went through a kind of apprenticeship ere they were admitted knights. See **KNIGHT**.

**NOVICE** is more particularly used in monasteries for a religious yet in his, or her, year of probation, and who has not made the vows.

In some convents, the sub-prior has the direction of the novices. In nunneries, the novices wear a white veil; the rest a black one.

**NOVICIATE**, a year of probation appointed for the trial of religious, whether or no they have a vocation, and the necessary qualities for living up to the rule; the observation whereof they are to bind themselves to by vow. The noviciate lasts a year at least; in some houses more. It is esteemed the bed of the civil death of a novice, who expires to the world by profession.

**NOVIODUNUM** (Cæsar), a town of the *Ædoui*, commodiously seated on the Liguris; the *Nivernum* of Antonine. Now *Nevers* in the Orleansois, on the Loire.—A second *Noviodunum* of the *Aulerci Diablintes*, in Gallia Celtica, (Antonine); called *Noviodunum*, (Ptolemy), and *Noningentum Retradum* by the moderns; *Nogente le Retrou*, capital of the duchy of Perche.—A third, of the *Bituriges*. (Cæsar): Now *Nueve sur Baranion*; a village 15 miles to the north of Bourges, towards Orleans.—A fourth, of *Mæsia Inferior*, (Ptolemy), situate on the Ister: now *Nivoz*, in *Bessa*, abia.—A fifth, of *Pannonia Superior*, (An-

tonine); now *Gurkfeld* in Carinthia.—A sixth *Noviodunum Sueffionum*, the same with *Augusta Sueffionum*.—A seventh, *Noviodunum* of the *Veromandui* in Gallia Belgica, (Cæsar): now *Noyon* in the Isle of France, on the borders of Picardy.

**NOVOGOROD WELICKI**, or *Great Novogorod*, a rich and very large town of the Russian empire, and capital of a duchy of the same name, with an archbishop's see, and a castle where the archbishop and the waiwode reside. It is commonly called the *grand magazine*, because hither they bring their rich merchandises that come from the Levant. It contains 180 churches and monasteries, and carries on a great trade in Russia leather. It is seated on the river *Wolcovi*, near the lake *Honen*. E. Long. 33. 40. N. Lat. 58. 23.

**NOVOGOROD WELICKI**, a province of Moscow, bounded on the north by Ingria; on the east by part of the duchy of *Belozero*, and that of *Tuera*, which also bounds it on the south, with the province of *Rzeva*; and on the west by *Plefcow*. It is full of lakes and forests; however, there are some places which produce corn, flax, hemp, honey, and wax.

**NOVOGOROD SERPSKOI**, a strong town of the Russian empire, and capital of a province of Siberia of the same name, seated on the river *Dubica*, in E. Long. 33. 20. N. Lat. 52. 30.

**NOVOGORODECK**, a town of Lithuania, and capital of a palatinate of the same name. It is a large town, and situated in a vast plain, in E. Long. 25. 30. N. Lat. 53. 45.

**NOURISHMENT**. See **NUTRITION**.

**NOURISHMENT of Vegetables**. See **AGRICULTURE**, Part I. Sect. 1. and 2. and **PLANTS**; also the article **COMPOSTS**.

**NOWED**, in heraldry, signifies "knotted," from the Latin *nodatus*; being applied to the tails of such creatures as are very long, and sometimes represented in coat-armour as tied up in a knot.

**NUAYHAS**, the *AGUE-TREE*; a name given by the Indians to a sort of Bamboo-cane, the leaves of which falling into the water, are said to impregnate it with such virtue, that the bathing in it afterwards will cure the ague. They use also a decoction of the leaves to dissolve coagulated blood, giving it internally, and at the same time rubbing the bruised part externally with it. It is said that this plant bears its flowers only once in its life; that it lives 60 years before these make their appearance; but that when they begin to shew themselves, it withers away in about a month afterwards; that is, as soon as it has ripened the seed. There seems to be something of fiction in the account of many other particulars relating to this tree in the *Horius Malabaricus*; but it seems certain, that the length of the stalks, or trunk, must be very great: for, in the gallery of *Leyden*, there is preserved a cane of it 28 feet long; and another not much shorter in the *Ashmolean museum* at Oxford, and which is more than eight inches in diameter; yet both these appear to be only parts of the whole trunk, they being nearly as large at one end as at the other.

**NUBECULA**, *LITTLE CLOUD*, in medicine, a term sometimes used for disease in the eye, wherein objects appear as through a cloud or mist.

Nubecula

Number.

The nubecula seems to arise from certain gross particles detained in the pores of the cornea, or swimming in the aqueous humour, and thus intercepting the rays of light.

**NUBECULA**, or *Nubus*, is also used for what we otherwise call *albugo*. See **ALBUGO**.

**NUBECULA** is also used for a matter in form of a cloud, suspended in the middle of the urine.

**NUBIA**, a country of Africa, bounded on the north by Egypt, on the south by Abyssinia, on the east by the coast of Abesh or Abex, and on the west by Zaara and Nigritia. It is said to be 400 leagues in length, and 200 in breadth, and to be watered by a river which falls into the Nile; but of these dimensions we have little certainty, and nothing can be depended upon concerning the nature of the country or its inhabitants.

**NUCLEUS**, in general, denotes the kernel of a nut, or even any seed inclosed within a hulk. The term *nucleus* is also used for the body of a comet, otherwise called its *head*.

**NUDITIES**, in painting and sculpture, those parts of an human figure which are not covered with any drapery; or those parts where the carnation appears.

**NULLITY**, in law, signifies any thing that is null or void: thus there is a nullity of marriage, where persons marry within the degrees, or where infants marry without consent of their parents or guardians.

**NUMANIA**, a very noble city, the ornament of the Hither Spain, (Florus); as appears from the Numantine war: and though destroyed by the Romans under Scipio *Æmilianus*, it was afterwards no doubt restored, because mentioned not only by Ptolemy, but also by Antonine, who determines its situation between Uxama and Turisio; and Strabo says, the Durus run by it, while still recent and near its source. With 4000 men it held out a siege of 14 years, against 40,000 Romans. And all this it did, like another Sparta, without walls and without turrets; but this is doubtfully mentioned by authors.—*Numantini*, the people; who, after a tedious and close siege, and after struggling long with famine, at length destroyed themselves and their city by fire.

**NUMBER**, an assemblage of several units, or things of the same kind. See **ARITHMETIC**; and **METAPHYSICS**, n° 62—65.

Number, says Malcom, is either abstract or applicable: Abstract, when referred to things in general, without attending to their particular properties; and applicable, when considered as the number of a particular sort of things, as yards, trees, or the like.

When particular things are mentioned, there is always something more considered than barely their numbers; so that what is true of numbers in the abstract, or when nothing but the number of things is considered, will not be true when the question is limited to particular things: for instance, the number two is less than three; yet two yards is a greater quantity than three inches: and the reason is, because regard must be had to their different natures as well as number, whenever things of a different species are considered; for though we can compare the number of such things abstractedly, yet we cannot compare them in any applicable sense. And this difference is necessary to be considered, because upon it the true sense, and the possibility or impossibility, of some questions depend.

Number.

Number is unlimited in respect of increase; because we can never conceive a number so great, but still there is a greater. However, in respect of decrease, it is limited; unity being the first and least number, below which therefore it cannot descend.

*Kinds and Distinctions of NUMBERS.* Mathematicians, considering number under a great many relations, have established the following distinctions.

Broken numbers are the same with fractions. Cardinal numbers are those which express the quantity of units, as 1, 2, 3, 4, &c. whereas ordinal numbers are those which express order, as 1st, 2d, 3d, &c.

Compound number, one divisible by some other number besides unity; as 12, which is divisible by 2, 3, 4, and 6. Numbers, as 12 and 15, which have some common measure besides unity, are said to be compound numbers among themselves.

Cubic number is the product of a square number by its root: such is 27, as being the product of the square number 9, by its root 3. All cubic numbers, whose root is less than 6, being divided by 6, the remainder is the root itself: thus 27÷6 leaves the remainder 3; its root; 215, the cube of 6, being divided by 6, leaves no remainder; 343, the cube of 7, leaves a remainder 1, which, added to 6, is the cube root; and 512, the cube of 8, divided by 6, leaves a remainder 2, which, added to 6, is the cube root. Hence the remainders of the divisions of the cubes above 216, divided by 6, being added to 6, always gives the root of the cube so divided, till that remainder be 5, and consequently 11, the cube-root of the number divided. But the cubic numbers above this, being divided by 6, there remains nothing, the cube root being 12. Thus the remainders of the higher cubes are to be added to 12, and not to 6; till you come to 18, when the remainder of the division must be added to 18; and so on *ad infinitum*.

Determinate number is that referred to some given unit, as a ternary or three: whereas an indeterminate one is that referred to unity in general, and is called *quantity*.

Homogeneous numbers, are those referred to the same unit; as those referred to different units are termed *heterogeneous*.

Whole numbers are others called *integers*.

Rational number, is one commensurable with unity; as a number, incommensurable with unity, is termed *irrational*, or a *rad*.

In the same manner, a rational whole number is that whereof unity is an aliquot part; a rational broken number, that equal to some aliquot part of unity; and a rational mixed number, that consisting of a whole number and a broken one.

Even number, that which may be divided into two equal parts without any fraction, as 6, 12, &c. The sum, difference, and product, of any number of even numbers, is always an even number.

An evenly even number, is that which may be measured, or divided, without any remainder, by another even number, as 4 by 2.

An unevenly even number, when a number may be equally divided by an uneven number, as 20 by 5.

Uneven number, that which exceeds an even number, at least by unity, or which cannot be divided into

The sum or difference of two uneven numbers makes an even number; but the factum of two uneven ones makes an uneven number.

If an even number be added to an uneven one, or if the one be subtracted from the other, in the former case the sum, in the latter the difference, is an uneven number; but the factum of an even and uneven number is even.

The sum of any even number of uneven numbers is an even number; and the sum of any uneven number of uneven numbers is an uneven number.

Primitive or prime numbers, are those divisible only by unity, as 5, 7, &c. And prime numbers among themselves, are those which have no common measure besides unity, as 12 and 19.

Perfect number, that whose aliquot parts added together make the whole number, as 6, 28; the aliquot parts of 6 being 3, 2, and 1=6; and those of 28, being 14, 7, 4, 2, 1=28.

Imperfect numbers, those whose aliquot parts added together make either more or less than the whole. And these are distinguished into abundant and defective: an instance in the former case is 12, whose aliquot parts 6, 4, 3, 2, 1, make 16; and in the latter case 16, whose aliquot parts 8, 4, 2, and 1, make but 15.

Plain number, that arising from the multiplication of two numbers, as 6, which is the product of 3 by 2; and these numbers are called the *sides of the plane*.

Square number is the product of any number multiplied by itself; thus 4, which is the factum of 2 by 2, is a square number.

Even square number added to its root makes an even number.

Polygonal or polygonous numbers, the sums of arithmetical progressions beginning with unity: these, where the common difference is 1, are called *triangular numbers*; where 2, *square numbers*; where 3, *pentagonal numbers*; where 4, *hexagonal numbers*; where 5, *heptagonal numbers*, &c.

Pyramidal numbers, the sums of polygonous numbers, collected after the same manner as the polygons themselves, and not gathered out of arithmetical progressions, are called *first pyramidal numbers*: the sums of the first pyramidal are called *second pyramidal*, &c.

If they arise out of triangular numbers, they are called *triangular pyramidal numbers*; if out of pentagons, *first pentagonal pyramidal*.

From the manner of summing up polygonal numbers, it is easy to conceive how the prime pyramidal numbers are found, viz.

$$\frac{(a-2)n^3 + 3n^2 - (a-5)n}{6}$$

expresses all the prime pyramids.

The following curious property of the number 9 deserves to be remarked, That its products compose always either 9 or some lesser product of 9; if you add together all the characters, of which any of the former products is composed. Thus, of 18, 27, 36, which are products of 9, you make 9 by adding 1 to 8, 2 to 7, 3 to 6. Thus 369 is a product also of 9; and if you add 3, 6, and 9, you make 18, a lesser product of 9.

Golden NUMBER, See ASTRONOMY, n<sup>o</sup> 304-307.

NUMBERS, in poetry, oratory, &c. are certain measures, proportions, or cadences, which render a verse, period, or song, agreeable to the ear.

Poetical numbers consist in a certain harmony in the order, quantities, &c. of the feet and syllables, which make the piece musical to the ear, and fit for singing, for which all the verses of the ancients were intended. See POETRY.—It is of these numbers Virgil speaks in his ninth Eclogue, when he makes Lycidas say, *Numeros meministi, si verba tenerem*; meaning, that although he had forgot the words of the verses, yet he remembered the feet and measure of which they were composed.

Rhetorical or prosaic numbers are a sort of simple unaffected harmony, less glaring than that of verse, but such as is perceived and affects the mind with pleasure.

The numbers are that by which the style is said to be easy, free, round, flowing, &c. Numbers are things absolutely necessary in all writing, and even in all speech. Hence Aristotle, Tully, Quintilian, &c. lay down abundance of rules as to the best manner of intermixing dactyles, spondee, anapests, &c. in order to have the numbers perfect. The substance of what they have said, is reducible to what follows.

1. The style becomes numerous by the alternate disposition and temperature of long and short syllables, so as that the multitude of short ones neither render it too hasty, nor that of long ones too slow and languid: sometimes, indeed, long and short syllables are thrown together designedly without any such mixture, to paint the slowness or celerity of any thing by that of the numbers; as in these verses of Virgil:

*Illū inter sese magna vi brachia tollunt;*

and

*Radiū inter liquidum, celeres neque commovet alas.*

2. The style becomes numerous, by the intermixing words of one, two, or more syllables; whereas the too frequent repetition of monosyllables renders the style pitiful and grating. 3. It contributes greatly to the numerousness of a period, to have it closed by magnificent and well-sounding words. 4. The numbers depend not only on the nobleness of the words in the close, but of those in the whole tenor of the period. 4. To have the period flow easily and equally; the harsh concurrence of letters and words is to be studiously avoided, particularly the frequent meeting of rough consonants; the beginning the first syllable of a word with the last of the preceding; the frequent repetition of the same letter or syllable; and the frequent use of the like ending words. Lastly, the utmost care is to be taken left, in aiming at oratorical numbers, you should fall into poetical ones; and instead of prose, write verse.

Book of NUMBERS, the fourth book of the Pentateuch, taking its denomination from its numbering the families of Israel.

A great part of this book is historical, relating to several remarkable passages in the Israelites march through the wilderness. It contains a distinct relation of their several movements from one place to another, or their 42 stages through the wilderness, and many other things, whereby we are instructed and confirmed.

**Numerals.** ed in some of the weightiest truths that have immediate reference to God and his providence in the world. But the greatest part of this book is spent in enumerating those laws and ordinances, whether civil or ceremonial, which were given by God, but not mentioned before in the preceding books.

**NUMERAL LETTERS,** those letters of the alphabet which are generally used for figures; as I, one; V, five; X, ten; L, fifty; C, a hundred; D, five hundred; M, a thousand, &c.

It is not agreed how the Roman numerals originally received their value. It has been supposed that the Romans used M to denote 1000, because it is the first letter of *mille*, which is Latin for 1000; and C to denote 100, because it is the first letter of *centum*, which is Latin for 100. It has also been supposed, that D being formed by dividing the old M in the middle, was therefore appointed to stand for 500, that is, half as much as the M stood for when it was whole; and that L being half a C, was, for the same reason, used to denote 50. But what reason is there to suppose, that 1000 and 100 were the numbers which letters were first used to express? And what reason can be assigned why D, the first letter in the Latin word *decem*, ten, should not rather have been chosen to stand for that number, than for 500 because it had a rude resemblance to half an M? But if these questions could be satisfactorily answered, there are other numeral letters which have never yet been accounted for at all. These considerations render it probable, that the Romans did not, in their original intention, use letters to express numbers at all; the most natural account of the matter seems to be this:

The Romans probably put down a single stroke, I, for one, as is still the practice of those who score on a slate or with chalk: this stroke, I, they doubled, trebled, and quadrupled, to express 2, 3, and 4: thus, II. III. IIII. So far they could easily number the minims, or strokes, with a glance of the eye. But they presently found, that if more were added, it would soon be necessary to tell the strokes one by one: for this reason, when they came to 5, they expressed it by joining two strokes together in an acute angle thus, V; which will appear the more probable, if it be considered, that the progression of the Roman numbers is from 5 to 5, *i. e.* from the fingers on one hand to the fingers on the other.—Ovid has touched upon the original of this in his *Festorum* lib. iii. and *Virg.* lib. c. 1. has made the same remark.

After they had made this acute angle V, for five, they added the single strokes to it to the number of 4, thus, VI. VII. VIII. VIII. and then as the minims could not be further multiplied without confusion, they doubled their acute angle, by prolonging the two lines beyond their intersection thus, X, to denote two fives, or ten. After this they doubled, trebled, and quadrupled, this double acute angle thus, XX. XXX. XXXX. they then, for the same reason which induced them first to make a single and then to double it, joined two single strokes in another form, and instead of an acute angle, made a right angle L, to denote fifty. When this 50 was doubled, they then doubled the right angle thus C, to denote 100, and having numbered this double right angle four times, thus EE.

EE. EEE. when they came to the fifth number, as before, they reverted it, and put a single stroke before it thus II, to denote 500; and when this 500 was doubled, then they also doubled their double right angle, setting two double right angles opposite to each other, with a single stroke between them, thus CII to denote 1000: when this note for 1000 had been four times repeated, then they put down III for 5,000, EEEIII for 10,000, and IIIII for 50,000, EEEIIIIII for 100,000, IIIIIII for 500,000, and EEEIIIIIIII for one million.

That the Romans did not originally write M for 1000, and C for 100, but square characters, as they are written above, we are expressly informed by Paulus Manutius; but the corners of the angles being cut off by the transcribers for dispatch, these figures were gradually brought into what are now numeral letters. When the corners of CII, were made round, it stood thus CID, which is so near the Gothic M, that it soon deviated into that letter; foII having the corner made round, it stood thus ID, and then easily deviated into D. C also became a plain C by the same means; the single rectangle which denoted 50, was, without alteration, a capital L; the double acute angle was an X; the single acute angle a V consonant; and a plain single stroke, the letter I; and thus these seven letters, M, D, C, L, X, V, I, became numerals.

**NUMERATION, or NOTATION,** in arithmetic, the art of expressing in characters any number proposed in words, or of expressing in words any number proposed in char. cters. See **ARITHMETIC**, p. 653.

**NUMERICAL, NUMEROUS, or NUMERAL,** something belonging to numbers; as numerical algebra is that which makes use of numbers, instead of letters of the alphabet.—Also numerical difference is that by which one man is distinguished from another. Hence a thing is said to be numerically the same, when it is so in the strictest sense of the word.

**NUMIDA,** in ornithology, a genus belonging to the order of galline. On each side of the head there is a kind of coloured fleshy horn; and the beak is furnished with cere near the nostrils. There is but one species, the meagris, or Guinea-hen; a native of Africa. It is of the size of the common hen, but with a longer neck. Its body is sloped like that of a partridge, and its colour is all over a dark grey, very beautifully spotted with small white specks; there is a black ring round the neck; its head is reddish, and it is blue under the eyes. They naturally herd together in large numbers, and breed up their young in common; the females taking care of the broods of others, as well as of their own. Barbot informs us, that in Guinea they are in flocks of 200 or 300, that perch in trees, and feed on worms and grasshoppers; that they are run down and taken by dogs; and that their flesh is tender and sweet, generally white, though sometimes black. They breed very well with us.

**NUMIDIA,** an ancient kingdom of Africa, bounded on the north by the Mediterranean Sea; on the south by Gætulia, or part of Libya Interior; on the west by the Mulucha, a river which separated it from Mauritania; and on the east by the Tusca, another river which bounded it in common with Africa Propria. Dr Shaw has rendered it probable, that the river which formerly went under the denominations of

*Males,*

Numeration  
||  
Numidia.

<sup>1</sup> Numidia. *Malva, Malvana, Mulucha, and Molochatb*, is the same with that now called MULLOUBAH by the Algerines; in which case, the kingdom of Numidia must have extended upwards of 500 miles in length: its breadth, however, cannot be so well ascertained; but supposing it to have been the same with that of the present kingdom of Algiers, in the narrowest part it must have been at least 40 miles broad, and in the widest upwards of 100.

This country included two districts: one inhabited by the *Massyli*, and the other by the *Masæyli*; the latter being also called in after-times, *Mauritania Cæsariensis*, and the former *Numidia Propria*. The country of the Massyli, or, as some call it, *Terra Metagonitis*, was separated from the proper territory of Carthage by its eastern boundary the river Tufca, and from the kingdom of the Masæyli, or Mauritania Cæsariensis, by the river Ampaga. It seems to correspond with that part of the province of Constantia lying between the Zaine and the Wed al Kiber, which is above 130 miles long, and more than 100 broad. The sea-coast of this province is for the most part mountainous and rocky, answering to the appellation given to it by Abulfeda, viz. *El Edwaa, the high or lofty*. It is far from being equal in extent to the ancient country of the Masæyli, which, Strabo informs us, was yet inferior to the country of the Massyli. Its capital was Cirta, a place of very considerable note among the ancients.

<sup>2</sup> The most celebrated antiquarians agree, that the tract, extending from the isthmus of Suez to the lake Tritonis, was chiefly peopled by the descendants of Mizraim; and that the posterity of his brother Put, or Phut, spread themselves all over the country between that lake and the Atlantic ocean. To this notion Herodotus gives great countenance: for he tells us, that the Libyan Nomades, whose territories to the west were bounded by the Triton, agreed in their customs and manners with the Egyptians; but that the Africans from that river to the Atlantic Ocean, differed in almost all points from them. Ptolemy mentions a city called *Putea* near Adrametum; and Pliny, a river of Mauritania Tingitana, known by the name of *Fut, or Phut*; and the district adjacent to this river was called *Regio Phutensis*, which plainly alludes to the name of *Phut*. That word signifies *scattered, or dispersed*, which very well agrees with what Mela and Strabo relate of the ancient Numidians; so that we may, without any scruple, admit the Aborigines of this country to have been the descendants of Phut.

<sup>3</sup> The history of Numidia, during many of the early ages, is buried in oblivion. It is probable, however, that as the Phœnicians were masters of a great part of the country, these transactions had been recorded, and generally known to the Carthaginians. King Jarbas probably reigned here as well as in Africa Propria, if not in Mauritania, and other parts of Libya, when Dido began to build Byrsa. It appears from Justin, that about the age of Herodotus, the people of this country were called both *Africans* or *Libyans* and *Numidians*. Justin likewise intimates, that about this time the Carthaginians vanquished both the Moors or Mauritians, and Numidians; in consequence of which they were excused from paying the tribute which had

hitherto been demanded of them.

After the conclusion of the first Punic war, the African troops carried on a bloody contest against their masters the Carthaginians; and the most active in this rebellion, according to Diodorus Siculus, were a part of the Numidian nation named *Micatanians*. This fo incensed the Carthaginians, that after Hamilcar had either killed or taken prisoners all the mercenaries, he sent a large detachment to ravage the country of those Numidians. The commandant of that detachment executed his orders with the utmost cruelty, plundering the district in a terrible manner, and crucifying all the prisoners, without distinction, that fell into his hands. This filled the rest with such indignation and resentment, that both they and their posterity ever afterwards bore an implacable hatred to the Carthaginians.

<sup>4</sup> In the time of the second Punic war, Syphax, king of the Masæyli, entered into an alliance with the Romans, and gave the Carthaginians a considerable defeat. This induced Gala, king of the Massyli, to conclude a treaty with the Carthaginians, in consequence of which his son Masinissa marched at the head of a powerful army to give Syphax battle. The contest ended in favour of Masinissa; 30,000 of the Masæyli were put to the sword, and Syphax driven into Mauritania; and the like bad success attended Syphax in another engagement, where his troops were entirely defeated and dispersed.

Gala dying whilst his son Masinissa was acting at the head of the Numidian troops sent to the assistance of the Carthaginians in Spain, his brother Desfalces, according to the established rules of succession in Numidia, took possession of the Massylian throne. That prince dying soon after his accession, Capusa his eldest son succeeded him. But he did not long enjoy his high dignity; for one Mezetulus, a person of the royal blood, but an enemy to the family of Gala, found means to excite a great part of his subjects to revolt. A battle soon took place between him and Capusa; in which the latter was slain with many of the nobility, and his army entirely defeated. But tho' Mezetulus thus became possessed of the sovereignty, he did not think proper to assume the title of *king*, but styled himself guardian to Lacumaces, the surviving son of Desfalces, whom he graced with the royal title. To support himself in his usurpation, he married the dowager of Desfalces, who was Hannibal's niece, and consequently of the most powerful family in Carthage. In order to attain the same end, he sent ambassadors to Syphax, to conclude a treaty of alliance with him. In the mean time Masinissa, receiving advice of his uncle's death, of his cousin's slaughter, and of Mezetulus's usurpation, immediately passed over to Africa, and went to the court of Bocchar king of Mauritania, to solicit succours. Bocchar, sensible of the great injustice done Masinissa, gave him a body of 4000 Moors to escort him to his dominions. His subjects, having been apprised of his approach, joined him upon the frontiers with a party of 500 men. The Moors, in pursuance of their orders, returned home, as soon as Masinissa reached the confines of his kingdom. Notwithstanding which, and the small body that declared for him having accidentally met Lacumaces at Thapsus with an escort going

Numidia.

History of Syphax and Masinissa.

<sup>1</sup> Ancient division.

<sup>2</sup> Peopled by the descendants of Phut.

<sup>3</sup> Great part of the history unknown.

Numidia.

to implore Syphax's assistance, he drove him into the town, which he carried by assault, after a faint resistance. However, Lacumaces, with many of his men, found means to escape to Syphax. The fame of this exploit gained Masinissa great credit, inasmuch that the Numidians flocked to him from all parts, and, amongst the rest, many of his father Gala's veterans, who pressed him to make a speedy and vigorous push for his hereditary dominions. Lacumaces having joined Metzelus with a reinforcement of Massilyians, which he had prevailed upon Syphax to send to the assistance of his ally, the usurper advanced at the head of a numerous army to offer Masinissa battle; which that prince, though much inferior in numbers, did not decline. Hereupon an engagement ensued; which, notwithstanding the inequality of numbers, ended in the defeat of Lacumaces. The immediate consequence of this victory to Masinissa, was a quiet and peaceable possession of his kingdom; Metzelus and Lacumaces, with a few that attended them, flying into the territories of Carthage. However, being apprehensive that he should be obliged to sustain a war against Syphax, he offered to treat Lacumaces with as many marks of distinction as his father Gala had Desalecs; provided that prince would put himself under his protection. He also promised Metzelus pardon, and a restitution of all the effects forfeited by his treasonable conduct, if he would make his submission to him. Both of them readily complied with the proposal, and immediately returned home; so that the tranquillity and repose of Numidia would have been settled upon a solid and lasting foundation, had not this been prevented by Afridubal, who was then at Syphax's court. He insinuated to that prince, who was disposed to live amicably with his neighbours, "That he was greatly mistaken, if he imagined Masinissa would be satisfied with his hereditary dominions. That he was a prince of much greater capacity and ambition, than either his father Gala, his uncle Desalecs, or any of his family. That he had discovered in Spain marks of a most rare and uncommon merit. And that, in fine, unless his rising flame was extinguished before it came to too great a head, both the Massilyian and Carthaginian states would be infallibly consumed by it." Syphax, alarmed by these suggestions, advanced with a numerous body of forces into a district, which had long been in dispute between him and Gala, but was then in possession of Masinissa. This brought on a general action between these two princes; wherein the latter was totally defeated, his army dispersed, and he himself obliged to fly to the top of mount Balbus, attended only by a few of his horse. Such a decisive battle at the present juncture, before Masinissa was fixed in his throne, could not but put Syphax into possession of the kingdom of the Massyli. Masinissa in the mean time made nocturnal incursions from his post upon mount Balbus, and plundered all the adjacent country, particularly that part of the Carthaginian territory contiguous to Numidia. This district he not only thoroughly pillaged, but likewise laid waste with fire and sword, carrying off from thence an immense booty, which was bought by some merchants, who had put into one of the Carthaginian ports for that purpose. In fine, he did the Carthaginians more damage, not only by committing such

dreadful devastations, but by massacring and carrying into captivity vast numbers of their subjects on this occasion, than they could have sustained in a pitched battle, or one campaign of a regular war. Syphax, at the pressing and reiterated instances of the Carthaginians, sent Bocchar, one of his most active commanders, with a detachment of 4000 foot, and 2000 horse, to reduce this pestilent gang of robbers, promising him a great reward if he could bring Masinissa either alive or dead. Bocchar, watching an opportunity, surpris'd the Massilyians, as they were straggling about the country without any order or discipline; so that he took many prisoners, dispersed the rest, and pursued Masinissa himself, with a few of his men, to the top of the mountain where he had before taken post. Considering the expedition as ended, he not only sent many head of cattle, and the other booty that had fallen into his hands, to Syphax, but likewise all the forces, except 500 foot and 200 horse. With this detachment he drove Masinissa from the summit of the hill, and pursued him through several narrow passes and defiles, as far as the plains of Clupea. Here he so surrounded him, that all the Massilyians, except four, were put to the sword, and Masinissa himself, after having received a dangerous wound, escap'd with the utmost difficulty. As this was effected by crossing a rapid river, in which attempt two of his four attendants perished in the fight of the detachment that pursued him, it was rumoured all over Africa, that Masinissa also was drowned; which gave inexpressible pleasure to Syphax and the Carthaginians. For some time he lived undiscovered in a cave, where he was supported by the robberies of the two horsemen that had made their escape with him. But having cured his wound by the application of some medicinal herbs, he boldly began to advance towards his own frontiers, giving out publicly that he intended once more to take possession of his kingdom. In his march he was joined by about 40 horse, and, soon after his arrival amongst the Massyli, so many people flocked to him from all parts, that out of them he formed an army of 6000 foot, and 4000 horse. With these forces, he not only reinstated himself in the possession of his dominions, but likewise laid waste the borders of the Massilyli. This so irritated Syphax, that he immediately assembled a body of troops, and encamped very commodiously upon a ridge of mountains between Cirra and Hippo. His army he commanded in person; and detached his son Vermina, with a considerable force, to take a compass, and attack the enemy in the rear. In pursuance of his orders, Vermina set out in the beginning of the night, and took post in the place appointed him, without being discovered by the enemy. In the mean time Syphax decamped, and advanced towards the Massyli, in order to give them battle. When he had possessed himself of a rising ground that led to their camp, and concluded that his son Vermina must have formed the ambuscade behind them, he began the fight. Masinissa being advantageously posted, and his soldiers distinguishing themselves in an extraordinary manner, the dispute was long and bloody. But Vermina unexpectedly falling upon their rear, and by this means obliging them to divide their forces, which were scarce able before to oppose the main body under Syphax,

Numidia.

Nomidia. phax, they were soon thrown into confusion, and forced to betake themselves to a precipitate flight. All the avenues being blocked up, partly by Syphax, and partly by his son, such a dreadful slaughter was made of the unhappy Masilyli, that only Masinissa himself, with 60 horie, escaped to the Lesser Syrtis. Here he remained, betwixt the confines of the Carthaginians and Garamantes, till the arrival of Lælius and the Roman fleet on the coast of Africa. What happened immediately after this junction with the Romans, belongs to the article Rome.

It will be sufficient therefore in this place to observe, that, by the assistance of Lælius, Masinissa at last reduced Syphax's kingdom. According to Zonaras, Masinissa and Scipio, before the memorable battle of Zama, by a stratagem deprived Hannibal of some advantageous posts; which, with a solar eclipse happening during the heat of the action, and not a little intimidating the Carthaginian troops, greatly contributed to the victory the Romans obtained. At the conclusion therefore of the second Punic war, he was amply rewarded by the Romans for the important services he had done them. As for Syphax, after the loss of his dominions, he was kept in confinement for some time at Alba; from whence being removed in order to grace Scipio's triumph, he died at Tibur in his way to Rome. Zonaras adds, that his corpse was decently interred; that all the Numidian prisoners were released; and that Vermina, by the assistance of the Romans, took peaceable possession of his father's throne. However, part of the Massilylian kingdom had been before annexed to Masinissa's dominions, in order to reward that prince for his singular fidelity and close attachment to the Romans.

This seems to be countenanced by the epitomizer of Livy, who gives us sufficiently to understand, that Syphax's family, for a considerable term after the conclusion of the second Punic war, reigned in one part of Numidia. For he intimates, that Archobazanes, Syphax's grandson, and probably Vermina's son, hovered with a powerful army of Numidians upon the Carthaginian frontiers a few years before the beginning of the third Punic war. This he seems to have done, either in order to cover them, or to enable the Carthaginians to make an irruption into Masinissa's territories. Cato, however, pretended that these forces, in conjunction with those of Carthage, had a design to invade the Roman dominions, which he urged as a reason to induce the conscript fathers to destroy the African republic.

Nothing is further requisite, in order to complete the history of this famous prince, than to exhibit to our readers view some points of his conduct towards the decline, and at the close, of life; the wife dispositions made after his death by Æmilianus, in order to the regulation of his domestic affairs; and some particulars relating to his character, genius, and habit of body, drawn from the most celebrated Greek and Roman authors.

By drawing a line of circumvallation around the Carthaginian army under Afrubal, poised upon an eminence, Masinissa cut off all manner of supplies from them; which introduced both the plague and famine into their camp. As the body of Numidian troops employed in this blockade was not near so numerous as

the Carthaginian forces, it is evident, that the line here mentioned must have been extremely strong, and consequently the effect of great labour and art. The Carthaginians, finding themselves reduced to the last extremity, concluded a peace upon the following terms, which Masinissa dictated to them: 1. That they should deliver up all deserters. 2. That they should recal their exiles, who had taken refuge in his dominions. 3. That they should pay him 5000 talents of silver within the space of 50 years. 4. That their soldiers should pass under the yugum, each of them carrying off only a single garment. As Masinissa himself, though between 80 and 90 years of age, conducted the whole enterprise, he must have been extremely well versed in fortification, and other branches of the military art. His understanding likewise he must have retained to the last. This happened a short time before the beginning of the third Punic war. See CARTHAGE.

Soon after, the consuls landed an army in Africa, in Masinissa's order to lay siege to Carthage, without imparting to Masinissa their design. This not a little chagrined him, as it was contrary to the former practice of the Romans; who in the preceding war had communicated their intentions to him, and consulted him on all occasions. When, therefore, the consuls applied to him for a body of his troops to act in concert with their forces, he made answer, "That they should have a reinforcement from him when they stood in need of it." It could not but be provoking to him to consider, that after he had extremely weakened the Carthaginians, and even brought them to the brink of ruin, his pretended imperious friends should come to reap the fruits of his victory, without giving him the least intelligence of it.

However, his mind soon returned to its natural bias, which was in favour of the Romans. Finding his end approaching, he sent to Æmilianus, then a tribune in the Roman army, to desire a visit from him. What he proposed by this visit, was to invest him with full powers to dispose of his kingdom and estate as he should think proper, for the benefit of his children. The high idea he had entertained of that young hero's abilities and integrity, together with his gratitude and affection for the family into which he was adopted, induced him to take this step. But, believing that death would not permit him to have a personal conference with Æmilianus upon this subject, he informed his wife and children in his last moments, that he had empowered him to dispose in an absolute manner of all his possessions, and to divide his kingdom amongst his sons. To which he subjoined, "I require, that whatever Æmilianus may decree, shall be executed as punctually as if I myself had appointed it by my will." Having uttered these words, he expired, at above 90 years of age.

This prince, during his youth, had met with strange reverses of fortune. However, says Appian, being supported by the divine protection, he enjoyed an uninterrupted course of prosperity for a long series of years. His kingdom extended from Mauritania to the western confines of Cyrenaica; from whence it appears, that he was one of the most powerful princes of Africa. Many of the inhabitants of this vast tract he civilized in a wonderful manner, teaching them to cul-

Numidia.

Masinissa  
order to lay siege to Carthage, without imparting to Masinissa their design. This not a little chagrined him, as it was contrary to the former practice of the Romans; who in the preceding war had communicated their intentions to him, and consulted him on all occasions. When, therefore, the consuls applied to him for a body of his troops to act in concert with their forces, he made answer, "That they should have a reinforcement from him when they stood in need of it." It could not but be provoking to him to consider, that after he had extremely weakened the Carthaginians, and even brought them to the brink of ruin, his pretended imperious friends should come to reap the fruits of his victory, without giving him the least intelligence of it.But leaves  
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Numidia.

tivate their soil, and to reap those natural advantages which the fertility of some parts of their country offered them. He was of a more robust habit of body than any of his cotemporaries, being blessed with the greatest health and vigour; which was doubtless owing to his extreme temperance, and the toils he incessantly sustained. We are informed by Polybius, that sometimes he stood upon the same spot of ground from morning till evening, without the least motion, and at others continued as long in a sitting posture. He would remain on horseback for several days and nights together, without being sensible of the least fatigue. Nothing can better evince the strength of his constitution, than his youngest son, named *Stembal*, *Stembba*, or *Stembanus*, who was but four years old at his decease. Though 90 years of age, he performed all the exercises used by young men, and always rode without a saddle. Pliny tells us, that he reigned above 60 years. He was an able commander, and much facilitated the reduction of Carthage. Plutarch from Polybius observes, that the day after a great victory won over the Carthaginians, Masinissa was seen sitting at the door of his tent, eating a piece of brown bread. Suidas relates, that, to the last, he could mount his horse without any assistance. According to Appian, he left a numerous well-disciplined army, and an immense quantity of wealth, behind him.

Masinissa, before his death, gave his ring to his eldest son Micipsa; but left the distribution of all his other effects and possessions amongst his children, entirely to *Emilianus*. Of 54 sons that survived him, only three were legitimate, to wit, Micipsa, *Gulussa*, and *Maftanabal*. *Emilianus*, arriving at Cirta after he had expired, divided his kingdom, or rather the government of it, amongst these three, though to the others he gave considerable possessions. To Micipsa, who was a prince of a pacific disposition, and the eldest son, he assigned Cirta, the metropolis, for the place of his residence, in exclusion of the others. *Gulussa*, the next to him, being a prince of a military genius, had the command of the army, and the transacting of all affairs relating to peace or war, committed to his care. And *Maftanabal*, the youngest, had the administration of justice, an employment suitable to his education, allotted him. They enjoyed in common the immense treasures Masinissa had amassed, and were all of them dignified by *Emilianus* with the royal title. After he had made these wise dispositions, that young nobleman departed from Cirta, taking with him a body of Numidian troops, under the conduct of *Gulussa*, to reinforce the Roman army, that was then acting against the Carthaginians.

*Maftanabal* and *Gulussa* died soon after their father, as appears from the express testimony of *Sallust*. We find nothing more remarkable of these princes, besides what has been already related, than that the latter continued to assist the Romans in the third Punic war; and that the former was pretty well versed in the Greek language. Micipsa therefore became sole possessor of the kingdom of Numidia. In his reign, and the consulate of *M. Plautius Hypseus* and *M. Fulvius Flaccus*, according to *Orosius*, a great part of Africa was covered with locusts, which destroyed all the produce of the earth, and even devoured dry wood. But at last they were all carried by the wind into the African sea,

out of which being thrown in vast heaps upon the shore, a plague ensued, which swept away an infinite number of animals of all kinds. In Numidia only, perished 800,000 men, and in Africa Propria 200,000; amongst the rest, 30,000 Roman soldiers quartered in and about Utica for the defence of the last province. At Utica, in particular, the mortality raged to such a degree, that 1500 dead bodies were carried out of one gate in a day. Micipsa had two sons, *Adherbal* and *Hiempsal*, whom he educated in his palace, together with his nephew *Jugurtha*. That young prince was the son of *Maftanabal*; but his mother having been only a concubine, Masinissa had taken no great notice of him. However, Micipsa considering him as a prince of the blood, took as much care of him as he did of his own children.

*Jugurtha* possessed several eminent qualities, which gained him universal esteem. He was very handsome, and adorned with great strength of body, and adorned with the finest intellectual endowments. He did not devote himself, as young men commonly do, to a life of luxury and pleasure. He used to exercise himself, with persons of his age, in running, riding, hurling the javelin, and other manly exercises, suited to the martial genius of the Numidians; and though he surpassed all his fellow sportsmen, there was not one of them but loved him. The chase was his only delight; but it was that of lions, and other savage beasts. *Sallust*, to finish his character, tells us, that he excelled in all things, and spoke very little of himself.

So conspicuous an assemblage of fine talents and perfections, at first charmed Micipsa, who thought them an ornament to his kingdom. However, he soon began to reflect, that he was considerably advanced in years, and his children in their infancy; that mankind naturally thirsted after power, and that nothing was capable of making men run greater lengths than a vicious and unlimited ambition. These reflections soon excited his jealousy, and determined him to expose *Jugurtha* to a variety of dangers, some of which, he entertained hopes, might prove fatal to him. In order to this, he gave him the command of a body of forces which he sent to assist the Romans, who were at that time besieging *Namantia* in Spain. But *Jugurtha*, by his admirable conduct, not only escaped all those dangers, but likewise won the esteem of the whole army, and the friendship of *Scipio*, who sent a high character of him to his uncle Micipsa. However, that general gave him some prudent advice in relation to his future conduct; observing, no doubt, in him certain sparks of ambition, which, if lighted into a flame, he apprehended might one day be productive of the most fatal consequences.

Before this last expedition, Micipsa had endeavoured to find out some method of taking him off privately; but his popularity amongst the Numidians obliged that prince to lay aside all thoughts of this nature. After his return from Spain the whole nation almost adored him. The heroic bravery he had shewn there, his undaunted courage, joined to the utmost calmness of mind, which enabled him to preserve a just medium between a timorous foresight and an impetuous rashness, a circumstance rarely to be met with in persons of his age, and above all the advantageous testimonials of his conduct given by *Scipio*, attracted an universal

Numidia.

History of  
Jugurtha.8  
Is dreaded  
by king  
Masinissa.



Numidia. verfal esteem. Nay, Micipfa himfelf, charmed with the high idea the Roman general had entertained of his merit, changed his behaviour towards him; refolving, if poffible, to win his affection by kindnefs. He therefore adopted him, and declared him joint heir with his two fons to the crown. Finding, fome few years afterwards, that his end approached, he fent for all three to his bed-fide; where, in the prefence of the whole court, he defired Jugurtha to recollect with what extreme tendernes he had treated him, and confequently to confider how well he had deferved at his hands.

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He then intreated him to protect his children on all occafions; who, being before related to him by the ties of blood, were now by their father's bounty become his brethren. In order to fix him the more firmly in their intereft, he likewife complimented him upon his bravery, addrefs, and confummate prudence. He further intimated, that neither arms nor treafures conftitute the ftrength of a kingdom; but friends, who are neither won by arms nor gold, but by real fervices, and an inviolable fidelity. "Now where, (continued he), can we find better friends than in brothers? And how can that man who becomes an enemy to his relations, repose any confidence in, or depend upon frangers?" Then addreffing himfelf to Adherbal and Hiempfal, "And you, (faid he), I enjoy always to pay the higheft reverence to Jugurtha. Endeavour to imitate, and if poffible furpafs, his exalted merit, that the world may not hereafter obferve Micipfa's adopted fon to have reflected greater glory upon his memory than his own children." Soon after, Micipfa, who, according to Diodorus, was a prince of an amiable character, expired. Though Jugurtha did not believe the king to fpeak his real fentiments with regard to him, yet he feemed extremely pleafed with fo gracious a fpeech, and made him an anfwer fuitable to the occafion. However, that prince at the fame time was determined within himfelf to put in execution the fcheme he had formed at the fiege of Numantia, which was fuggefted to him by fome factious and abandoned Roman officers, with whom he there contracted an acquaintance. The purport of this fcheme was, that he fhould extort the crown by force from his two coufins, as foon as their father's eyes were clofed; which they infinuated might eafily be effected by his own valour, and the venality of the Romans. Accordingly, a fhort time after the old king's death, he found means to affaffinate Hiempfal in the city of Thirmidia where his treafures were deposited, and drive Adherbal out of his dominions. That unhappy prince found himfelf obliged to fly to Rome, where he endeavoured to engage the confcript fathers to efpoufe his quarrel; but, notwithstanding the juftice of his caufe, they had not virtue enough effectually to fupport him. Jugurtha's embaffadors, by diftributing vaft fums of money amongst the fenators, brought them fo far over, that a majority palliated his inhuman proceedings. This encouraged thofe minifters to declare, that Hiempfal had been killed by the Numidians on account of his exceffive cruelty; that Adherbal was the aggreflor in the late troubles, and that he was only chagrined becaufe he could not make that havoc amongst his countrymen he would willingly have done. They therefore intreated the fenate to form a judgment of Jugurtha's behaviour in Africa from his conduct at Numantia, rather than from

the fuggeftions of his enemies. Upon which, by far the greateft part of the fenate difcovered themfelves prejudiced in his favour. A few however, that were not loft to honour, nor abandoned to corruption, infifted upon bringing him to condign punifhment. But as they could not prevail, he had the beft part of Numidia allotted him, and Adherbal was forced to retire fatisfied with the other.

Jugurtha finding now by experience, that every thing was venal at Rome, as his friends at Numantia had of the before informed him, thought he might perfufe his towering projects without any obfturbation from that quarter. He therefore, immediately after the laft divifion of Micipfa's dominions, threw off the mask, and attacked his coufin by open force. As Adherbal was a prince of a pacific difpofition, and almoft in all refpects the reverse of Jugurtha, he was by no means a match for him. The latter therefore pillaged the former's territories, burned feveral of his fortreffes, and over-ran a good part of his kingdom without oppofition. Adherbal, depending on the friendship of the Romans, which his father in his laft moments affured him would be a ftronger fupport to him than all the troops and treafures in the univerfe, difpatched deputies to Rome to complain of thefe hoftilities. But whilst he loit his time in fending thither fruitlefs deputations, Jugurtha overthrew him in a pitched battle, and foon after flut him up in Cirta. During the fiege of this city, a Roman commiffion arrived there, in order to perfuade both parties to an accommodation; but finding Jugurtha untractable, the commiffioners returned home without fo much as conferring with Adherbal. A fecond deputa-<sup>11</sup> tion, compofed of fenators of the higheft diftinction, with Emilius Scaurus, prefident of the fenate, at their head, landed fome time after at Utica, and fummoned Jugurtha to appear before them. That prince at firft feemed to be under dreadful apprehenfions, efppecially as Scaurus reproached him with his enormous crimes, and threatened him with the resentment of the Romans if he did not immediately raife the fiege of Cirta. However, the Numidian by his addrefs, and the irrefiftible power of gold, as was afterwards fufpected at Rome, fo mollified Scaurus, that he left Adherbal at his mercy. In fine, Jugurtha had at laft Cirta furrendered to him; upon condition only, that he fhould fpare the life of Adherbal. But the mercilefs tyrant, in violation of the laws of nature and humanity, as well as the capitulation, when he had got poffeffion of the town, ordered him to be put to a moft cruel death. The merchants likewife, and all the Numidians in the place capable of bearing arms, he caufed, without diftinction, to be put to the fword.

Every perfon at Rome infpired with any fentiments of humanity, was ftruck with horror at the news of this tragical event. However, all the venal fenators ftill concurred with Jugurtha's minifters in palliating his enormous crimes. Notwithstanding which, the people, excited thereto by Caius Memmius their tribune, who bitterly inveighed againft the venality of the fenate, refolved not to let fo flagrant an inftance of villany go unpunifhed. This difpofition in them induced the confcript fathers likewife to declare their intention to chaftife Jugurtha. In order to this, an army was levied to invade Numidia, and the command of it given to the conful Calpurnius Bellicia, a perfon of good abili-

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Numidia.

abilities, but rendered unfit for the expedition he was to go upon by his insatiable avarice. Jugurtha being informed of the great preparations making at Rome to attack his dominions, sent his son thither to avert the impending storm. The young prince was plentifully supplied with money, which he had orders to distribute liberally amongst the leading men. But Bessia, proposing to himself great advantages from an invasion of Numidia, defeated all his intrigues, and got a decree passed, ordering him and his attendants to depart Italy in ten days, unless they were come to deliver up the king himself, and all his territories, to the republic by way of dedication. Which decree being notified to them, they returned without so much as having entered the gates of Rome; and the consul soon after landed with a powerful army in Africa. For some time he carried on the war there very briskly, reduced several strongholds, and took many Numidians prisoners. But upon the arrival of Scaraus, a peace was granted Jugurtha upon advantageous terms. That prince coming from Vacca, the place of his residence, to the Roman camp, in order to confer with Bessia and Scaraus, and the preliminaries of the treaty being immediately after settled between them in private conferences, every body at Rome was convinced that the prince of the senate and the consul had to their avarice sacrificed the republic. The indignation therefore of the people in general, displayed itself in the strongest manner. Memmius also fired them with his speeches. It was therefore resolved to dispatch the prætor Cassius, a person they could confide in, to Numidia, to prevail upon Jugurtha to come to Rome, that they might learn from the king himself which of their generals and senators had been seduced by the pestilent influence of corruption. Upon his arrival there, he found means to bribe one Bebbius Salca, a man of great authority amongst the plebeians, but of insatiable avarice, by whose assistance he escaped with impunity. Nay, by the efficacy of gold, he not only eluded all the endeavours of the people of Rome to bring him to justice, but likewise enabled Bomilcar, one of his attendants, to get Maffiva, an illegitimate son of Micipsa, assassinated in the streets of Rome. That young prince was advised by many Romans of probity, well-wishers to the family of Masinissa, to apply for the kingdom of Numidia; which coming to Jugurtha's ears, he prevented the application by this execrable step. However, he was obliged to leave Italy immediately.

Jugurtha had scarce set foot in Africa when he received advice, that the senate had annulled the shameful peace concluded with him by Bessia and Scaraus. Soon after, the consul Albinus transported a Roman army into Numidia, flattering himself with the hopes of reducing Jugurtha to reason before the expiration of his consulate. In this, however, he found himself deceived; for that crafty prince, by various artifices so amused and imposed upon Albinus, that nothing of moment happened that campaign. This rendered him strongly suspected of having betrayed his country, after the example of his predecessors. His brother Aulus, who succeeded him in the command of the army, was still more unsuccessful; for after passing from before Suthul, where the king's treasures were deposited, he marched his forces into a desile out of which he found it impossible to extricate himself. He therefore was

Numidia.

obliged to submit to the ignominious ceremony of passing under the *jugum*, with all his men, and to quit Numidia entirely in ten days time, in order to deliver his troops from immediate destruction. The avaricious disposition of the Roman commander had prompted him to besiege Suthul, the possession of which place he imagined would make him master of all the wealth of Jugurtha, and consequently paved the way to such a scandalous treaty. However, this was declared void as soon as known at Rome, as being concluded without the authority of the people. The Roman troops retired into Africa Propria, which they had now reduced into the form of a Roman province, and there took up their winter-quarters.

In the mean time Caius Mamilius Limetanus, tribune of the people, excited the plebeians to inquire into the conduct of those persons by whose assistance Jugurtha had found means to elude all the decrees of the senate. This put the body of the people into a great ferment; which occasioned a prosecution of the guilty senators, that was carried on, for some time, with the utmost heat and violence. Lucius Metellus<sup>12</sup> the consul, during these transactions, had Numidia assigned him for his province, and consequently was appointed general of the army destined to act against Jugurtha. As he perfectly disregarded wealth, the Numidian found him superior to all his temptations; which was a great mortification to him. To this he joined all the other virtues which constitute the great captain; so that Jugurtha found him in all respects inaccessible. That prince therefore was now forced to regulate his conduct according to the motions of Metellus, with the greatest caution, and to exert his utmost bravery, in order to compensate for that hitherto so favourable expedient which now began to fail him. Marius, Metellus's lieutenant, being likewise a person of uncommon merit, the Romans reduced Vacca, a large opulent city, and the most celebrated mart in Numidia. They also defeated Jugurtha in a pitched battle; overthrew Bomilcar, one of his generals, upon the banks of the Muthullus; and, in fine, forced the Numidian monarch to take shelter in a place rendered almost inaccessible by the rocks and woods with which it was covered. However, Jugurtha signified himself in a surprising manner, exhibiting all that could be expected from the courage, abilities, and attention of a consummate general, to whom despair administers fresh strength, and suggests new lights. But his troops could not make head against the Romans; they were again worsted by Marius, though they obliged Metellus to raise the siege of Zama. Jugurtha therefore, finding his country every where ravaged, his most opulent cities plundered, his fortresses reduced, his towns burnt, vast numbers of his subjects put to the sword and taken prisoners, began to think seriously of coming to an accommodation with the Romans. His favourite Bomilcar, in whom he reposed the highest confidence, but who had been gained over to the enemy by Metellus, observing this disposition, found it no difficult matter to persuade him to deliver up his elephants, money, arms, horses, and deserters, in whom the main strength of his army consisted, into the hands of the Romans. Some of these last, in order to avoid the punishment due to their crime, retired to Bocchus king of Mauritania, and lifted in his service. But Metellus ordering

<sup>12</sup> Metellus sent against Jugurtha.

<sup>13</sup> Who is betrayed by Bomilcar.

<sup>14</sup> *Numidia.* ordering him to repair to Tifidium, a city of Numidia, there to receive farther directions, and his refusing a compliance with that order, hostilities were renewed with greater fury than ever. Fortune now seemed to declare in favour of Jugurtha: he retook Vacca, and massacred all the Roman garrison, except Turpilius the commandant. However, soon after, a Roman legion seized again upon it, and treated the inhabitants with the utmost severity. About this time, one of Masinaba's sons, named *Gauda*, whom Micipsa in his will had appointed to succeed to the crown in case his two legitimate sons and Jugurtha died without issue, wrote to the senate in favour of Marius, who was then endeavouring to supplant Metellus. That prince having his understanding impaired by a declining state of health, fell a more easy prey to the base and infamous adulation of Marius. The Roman, soothing his vanity, assured him, that as he was the next heir to the crown, he might depend upon being fixed upon the Numidian throne, as soon as Jugurtha was either killed or taken; and that this must in a short time happen, when once he appeared at the head of the Roman army with an unlimited commission. Soon after, Bomilcar and Nabdalla formed a design to assassinate Jugurtha, at the instigation of Metellus; but this being detected, Bomilcar and most of his accomplices suffered death. The plot however had such an effect upon Jugurtha, that he enjoyed afterwards no tranquillity or repose. He suspected persons of all denominations, Numidians as well as foreigners, of some black designs against him. Perpetual terrors sat brooding over his mind; insomuch that he never got a wink of sleep but by stealth, and often changed his bed in a low plebeian manner. Starting from his sleep, he would frequently snatch his sword, and break out into the most doleful cries: So strongly was he haunted by a spirit of fear, jealousy, and distraction!

Jugurtha having destroyed great numbers of his friends on suspicion of their having been concerned in the late conspiracy, and many more of them deserting to the Romans and Bocchus king of Mauritania, he found himself, in a manner, destitute of counsellors, generals, and all persons capable of assisting him in carrying on the war. This threw him into a deep melancholy, which rendered him dissatisfied with every thing, and made him fatigue his troops with a variety of contradictory motions. Sometimes he would advance with great celerity against the enemy, and at others retreat with no small swiftness from them. Then he resumed his former courage; but soon after despaired either of the valour or fidelity of the forces under his command. All his movements therefore proved unsuccessful, and at last he was forced by Metellus to a battle. That part of the Numidian army which Jugurtha commanded, behaved with some resolution; but the other fled at the first onset. The Romans therefore entirely defeated them, took all their standards, and made a few of them prisoners. Not many of them were slain in the action; since, as Sallust observes, the Numidians trusted more to their heels than to their arms for safety in this engagement.

Metellus pursued Jugurtha and his fugitives to Thala. His march to this place being through vast deserts, was extremely tedious and difficult. But being supplied with leathern bottles and wooden vessels

*Numidia.* of all sizes taken from the huts of the Numidians, which were filled with water brought by the natives, who had submitted to him, he advanced towards that city. He had no sooner begun his march, than a most copious shower of rain, a thing very uncommon in those deserts, proved a great and seasonable refreshment to his troops. This so animated them, that upon their arrival before Thala, they attacked the town with such vigour, that Jugurtha, with his family, and treasures deposited therein, thought proper to abandon it. After a brave defence, it was reduced; the garrison, consisting of Roman deserters, setting fire to the king's palace, and consuming themselves, together with every thing valuable to them, in the flames. Jugurtha, being now reduced to great extremities, retired into Gætulia, where he formed a considerable corps. From thence he advanced to the confines of Mauritania; and engaged Bocchus king of that country, who had married his daughter, to enter into an alliance with him. In consequence of which, having reinforced his Gætulian troops with a powerful body of Mauritians, he turned the tables upon Metellus, and obliged him to keep close within his entrenchments. Sallust informs us, that Jugurtha bribed Bocchus's ministers to influence that prince in his favour; and that having obtained an audience, he insinuated, that, should Numidia be subdued, Mauritania must be involved in its ruin, especially as the Romans seemed to have vowed the destruction of all the thrones in the universe. In support of what he advanced, he produced several instances very apposite to the point in view. However, the same author seems to intimate, that Bocchus was determined to assist Jugurtha against his enemies by the slight the Romans had formerly shewn him. That prince, at the first breaking out of the war, had sent ambassadors to Rome, to propose an offensive and defensive alliance to the republic; which, though of the utmost consequence to it at that juncture, a few of the most venal and infamous senators, who were abandoned to corruption, prevented from taking effect. This undoubtedly wrought more powerfully upon Bocchus in favour of Jugurtha, than the relation he stood in to him: For both the Moors and Numidians adapted the number of their wives to their circumstances, so that some had 10, 20, &c. to their share; their kings therefore were unlimited in this particular, and of course all degrees of affinity resulting to them from marriage had little force. It is observable, that the posterity of those ancient nations have the same custom prevailing amongst them at this day.

Such was the situation of affairs in Numidia, when Metellus received advice of the promotion of Marius to the consulate. But, notwithstanding this injurious treatment, he generously endeavoured to draw off Bocchus from Jugurtha, though this would facilitate the reduction of Numidia for his rival. To this end ambassadors were dispatched to the Mauritanian court, who intimated to Bocchus, "That it would be highly imprudent to come to a rupture with the Romans without any cause at all; and that he had now a fine opportunity of concluding a most advantageous treaty with them, which was much preferable to a war. To which they added, that whatever dependence he might place upon his riches, he ought

<sup>14</sup> A conspiracy against him.

<sup>15</sup> He is defeated by Metellus.

<sup>16</sup> Marius succedens Metellus.

not

Numidia.

not to run the hazard of losing his dominions by embroiling himself with other states, when he could easily avoid this; that it was much easier to begin a war than to end it, which it was in the power of the victor alone to do; that, in fine, he would by no means consult the interest of his subjects if he followed the desperate fortunes of Jugurtha." To which Bocchus replied, "That for his part there was nothing he wished for more than peace; but that he could not help pitying the deplorable condition of Jugurtha; that if the Romans, therefore, would grant that unfortunate prince the same terms they had offered him, he would bring about an accommodation." Metellus let the Mauritanian monarch know, that it was not in his power to comply with what he desired. However, he took care to keep up a private negotiation with him till the new consul Marius's arrival. By this conduct he served two wise ends. First, he prevented thereby Bocchus from coming to a general action with his troops; which was the very thing Jugurtha desired, as hoping that this, whatever the event might be, would render a reconciliation betwixt him and the Romans impracticable. Secondly, this inaction enabled him to discover something of the genius and disposition of the Moors; a nation, of whom the Romans, till then, had scarce formed any idea; which, he imagined, might be of no small service, either to himself or his successors, in the future prosecution of the war.

Jugurtha, being informed, that Marius, with a numerous army, was landed at Utica, advised Bocchus to retire, with part of the troops, to some place of difficult access, whilst he himself took post upon another inaccessible spot with the remaining corps. By this measure, he hoped the Romans would be obliged to divide their forces, and consequently be more exposed to his efforts and attacks. He likewise imagined, that seeing no formidable body appear, they would believe the enemy in no condition to make head against them; which might occasion a relaxation of discipline, the usual attendant of a too great security, and consequently produce some good effect. However, he was disappointed in both these views. For Marius, far from suffering a relaxation of discipline to take place, trained up his troops, which consisted chiefly of new levies, in so perfect a manner, that they were soon equal in goodness to any consular army that ever appeared in the field. He also cut off great numbers of the Gætulian marauders, defeated many of Jugurtha's parties, and had like to have taken that prince himself near the city of Cirta. These advantages, though not of any great importance, intimidated Bocchus, who now made overtures for an accommodation; but the Romans, not being sufficiently satisfied of his sincerity, gave no great attention to them. In the mean time Marius pushed on his conquests, reducing several places of less note, and at last resolved to besiege Capta. That this enterprize might be conducted with the greater secrecy, he suffered not the least hint of his design to transpire, even amongst any of his officers. On the contrary, in order to blind them, he detached A. Manlius, one of his lieutenants, with some light-armed cohorts, to the city of Lares, where he had fixed his principal magazine, and deposited the military chest. Before Manlius left the camp, that

he might the more effectually amuse him, he intimated, that himself with the army should take the same route in a few days: but instead of that, he bent his march towards the Tanais, and in six days time arrived upon the banks of that river. Here he pitched his tents for a short time, in order to refresh his troops; which having done, he advanced to Capta, and made himself master of it. As the situation of this city rendered it extremely commodious to Jugurtha, whose plan of operations, ever since the commencement of the war, it had exceedingly favoured, he levelled it with the ground after it had been delivered up to the soldiers to be plundered. The citizens likewise, being more strongly attached to that prince than any of the other Numidians, on account of the extraordinary privileges he indulged them with, and of course bearing a more implacable hatred to the Romans, he put to the sword or sold for slaves. The true motive of the consul's conduct on this occasion seems here to be assigned; though we are told by Salust, in conformity to the Roman genius, that neither avarice nor resentment prompted him to so barbarous an action, but only a desire to strike a terror into the Numidians.

The Numidians, ever after this exploit, dreaded the very name of Marius; who now, in his own opinion, had eclipsed the glory of all his predecessor's great achievements, particularly the reduction of Thala, a city, in strength and situation, nearly resembling Capta. Following his blow, he gradually presented himself before most of the places of strength in the enemy's country; many of which either opened their gates, or were abandoned, at his approach, being terrified with what had happened to the unfortunate citizens of Capta. Others taking by force, he laid in ashes; and in short, filled the greatest part of Numidia with blood, horror, and confusion. Then, after an obstinate defence, he reduced a castle that seemed impregnable, seated not far from Muluca, where Jugurtha kept part of his treasures. In the mean time, Jugurtha kept not being able to prevail upon Bocchus, by his repeated solicitations, to advance into Numidia, where he found himself greatly pressed, was obliged to have recourse to his usual method of bribing the Mauritanian ministers, in order to put that prince in motion. He also promised him a third part of his kingdom, provided they could either drive the Romans out of Africa, or get all the Numidian dominions confirmed to him by treaty.

So considerable a cession could not fail of engaging Bocchus to support Jugurtha with his whole power. The two African monarchs therefore, having joined their forces, surprised Marius near Cirta as he was going into winter-quarters. The Roman general was so pushed on this occasion, that the barbarians thought themselves certain of victory, and doubted not but they should be able to extinguish the Roman name in Numidia. But their incaution and too great security enabled Marius to give them a total defeat; which was followed four days after by so complete an overthrow, that their numerous army, consisting of 90,000 men, by the accession of a powerful corps of Moors, commanded by Bocchus's son Volux, was entirely ruined. Sylla, Marius's lieutenant, most eminently distinguished himself in the last action, which laid the foundation

17  
He gains a  
great advantage  
over Jugurtha.

Numidia.

18  
Jugurtha  
entirely de-  
feated.

Numidia. of his future greatness. Bocchus, now looking upon Jugurtha's condition as desperate, and not being willing to run the risk of losing his dominions, shewed a disposition to clap up a peace with Rome. However, the republic gave him to understand, that he must not expect to be ranked amongst its friends, till he had delivered up into the consul's hands Jugurtha, the inveterate enemy of the Roman name. The Mauritanian monarch, having entertained an high idea of an alliance with that state, resolved to satisfy it in this particular; and was confirmed in his resolution by one Dabar, a Numidian prince, the son of Massugrada, and descended by his mother's side from Masinissa. Being closely attached to the Romans, and extremely agreeable to Bocchus on account of his noble disposition, he defeated all the intrigues of Aspar, Jugurtha's minister. Upon Sylla's arrival at the Mauritanian court, the affair there seemed to be entirely settled. However, Bocchus, who was for ever projecting new designs, and, like the rest of his countrymen, in the highest degree perfidious, debated within himself, whether he should sacrifice Sylla or Jugurtha, who were both then in his power. He was a long time fluctuating with uncertainty, and combated by a contrariety of sentiments. The sudden changes, which displayed themselves in his countenance, his air, and his whole person, evidently shewed how strongly his mind was agitated. But at last he returned to his first design, to which the bias of his mind seemed naturally to lead him. He therefore delivered up Jugurtha into the hands of Sylla, to be conducted to Marius; who, by that successful event, happily terminated this dangerous war. The kingdom of Numidia was now reduced to a new form: Bocchus, for his important services, had the country of the Massylii, contiguous to Mauritania, assigned him; which, from this time, took the name of *New Mauritania*. Numidia Propria, or the country of the Massly, was divided into three parts; one of which was given to Hiempsal, another to Mandrestal, both descendants of Masinissa; and the third the Romans annexed to Africa Propria, or the Roman province adjacent to it. What became of Jugurtha after he had graced Marius's triumph, at which ceremony he was led in chains, together with his two sons, through the streets of Rome, our readers will find related at large in a former part of this work.

Jugurtha's two sons survived him, but spent their lives in captivity at Venusia. However, one of them, named *Oxyntas*, was, for a short time, released from his confinement by Aponius, who besieged Aceræ in the war between the Romans and the Italian allies. That general brought this prince to his army, where he treated him as king, in order to draw the Numidian forces off from the Roman service. Accordingly those Numidians no sooner heard that the son of their old king was fighting for the allies, than they began to desert by companies; which obliged Julius Cæsar the consul to part with all his Numidian cavalry, and send them back into Africa. Some few years after this event, Pompey defeated Cneius Domitius Ahenobarbus, and Hiarbas, one of the kings of Numidia, killing 17,000 of their men upon the spot. Not satisfied with this victory, that general pursued the fugitives to their camp, which he soon forced, put Domitius

to the sword, and took Hiarbas prisoner. He then reduced that part of Numidia which belonged to Hiarbas, who seems to have succeeded Mandrestal abovementioned; and gave it to Hiempsal, a neighbouring Numidian prince, descended from Masinissa, who had always opposed the Marian faction.

Suetonius informs us, that a dispute happened between Hiempsal and one Masintha, a noble Numidian, whom, it is probable, he had in some respect injured when Julius Cæsar first began to make a figure in the world. The same author adds, that Cæsar warmly espoused the cause of Masintha, and even grossly insulted Juba, Hiempsal's son, when he attempted to vindicate his father's conduct on this occasion. He pulled him by the beard, than which a more unpardonable affront could not be offered to an African. In short, he screened Masintha from the insults and violence of his enemies; from whence a reason may be assigned for Juba's adhering so closely afterwards to the Pompeian faction.

In consequence of the indignity Cæsar had offered Juba, and the disposition it had occasioned, that prince did Cæsar great damage in the civil wars betwixt him and Pompey. By a stratagem he drew Curio, one of his lieutenants, to a general action, which it was his interest at that time to have avoided. He caused it to be given out all over Africa Propria and Numidia, that he was retired into some remote country at a great distance from the Roman territories. This coming to Curio's ears, who was then besieging Utica, it hindered him from taking the necessary precautions against a surprize. Soon after, the Roman general receiving intelligence that a small body of Numidians was approaching his camp, he put himself at the head of his forces in order to attack them, and, for fear they should escape, began his march in the night, looking upon himself as sure of victory. Some of their advanced posts he surprized asleep, and cut them to pieces; which still farther animated him. In short, about day-break he came up with the Numidians, whom he attacked with great bravery, though his men were then fasting, and vastly fatigued by their forced and precipitate march. In the mean time, Juba, who, immediately after the propagation of the rumour abovementioned, had taken care to march privately, with the main body of the Numidian army, to support the detachment sent before to decoy Curio, advanced to the relief of his men. The Romans had met with a great resistance before he appeared; so that he easily broke them, killed Curio, with a great part of his troops, upon the spot, pursued the rest to their camp, which he plundered, and took many of them prisoners. Most of the fugitives, who endeavoured to make their escape on board the ships in the port of Utica, were either slain by the pursuers, or drowned. The remainder fell into the hands of Varus, who would have saved them; but Juba, who arrogated to himself the honour of this victory, ordered most of them to be put to the sword.

This victory infused new life and vigour into the Pompeian faction, who thereupon conferred great honours upon Juba, and gave him the title of *king of all Numidia*. But Cæsar and his adherents declared him an enemy to the state of Rome, adjudging to Bocchus and Bogud, two African princes entirely in their intere,

Numidia.

terest, the sovereignty of his dominions. Juba afterwards, uniting his forces with those of Scipio, reduced Cæsar to great extremities, and would in all probability have totally ruined him, had he not been relieved by Publius Sittius. That general, having formed a considerable corps, consisting of Roman exiles, and Mauritanian troops sent him by Bocchus, according to Dio, or, as Cæsar will have it, Bogud, made an irruption into Gætulia and Numidia, whilst Juba was employed in Africa Propria. As he ravaged these countries in a dreadful manner, Juba immediately returned with the best part of his army, to preserve them from utter destruction. However, Cæsar knowing his horse to be afraid of the enemy's elephants, did not think proper to attack Scipio in the absence of the Numidian, till his own elephants, and a fresh reinforcement of troops, hourly expected, arrived from Italy. With this accession of strength, he imagined himself able to give a good account, both of the Roman forces with which he was to cope, and the barbarians. In the mean time Scipio dispatched reiterated expresses to Juba to hasten to his assistance; but could not prevail upon him to move out of Numidia, till he had promised him the possession of all the Roman dominions in Africa, if they could from thence expel Cæsar. This immediately put him in motion; so that, having sent a large detachment to make head against Sittius, he marched with the rest of his troops to assist Scipio. However, Cæsar at last overthrew Scipio, Juba, and Labienus, near the town of Thapsus, and forced all their camps. As Scipio was the first surpris'd and defeated, Juba fled into Numidia, without waiting for Cæsar's approach; but the body of the Numidians detached against Sittius, having been broken and dispersed by that general, none of his subjects there would receive him. Abandoned therefore to despair, he sought death in a single combat with Petreius, and, having killed him, caused himself to be dispatched by one of his slaves.

24  
Numidia  
reduced to  
the form of  
a province.

After this decisive action, and the reduction of Africa Propria, Cæsar made himself master of Numidia, which he reduced to a Roman province, appointing Crispus Sallustius to govern it in quality of proconsul, with private instructions to pillage and plunder the inhabitants, and, by that means, put it out of their power ever to shake off the Roman yoke. However, Bocchus and Bogud still preserved a sort of sovereignty in the country of the Massælyli and Mauritania, since the former of those princes, having deserted Cæsar, sent an army into Spain to assist the Pompeians; and the latter, with his forces, determined victory to declare for Cæsar at the ever memorable battle of Munda. Bogud, afterwards siding with Anthony against Octavius, sent a body of forces to assist him in Spain; at which time the Tingitanians revolting from him, Bocchus, with an army composed of Romans in the interest of Octavius, who passed over from Spain into Africa, and his own subjects, possessed himself of Mauritania Tingitana. Bogud fled to Antony; and Octavius, after the conclusion of the war, honoured the inhabitants of Tingi with all the privileges of Roman citizens. He likewise confirmed Bocchus king of Mauritania Cæsariensis, or the country of the Massælyli, in the possession of Tingitania, which he had conquered, as a reward for his important services. In

he imitated the example of his great predecessor Julius Cæsar, who divided some of the fruitful plains of Numidia among the soldiers of P. Sittius, who had conquered great part of that country, and appointed Sittius himself sovereign of that district. Sittius, as has been intimated above, having taken Cirta, killed Sabura Juba's general, entirely dispersed his forces, and either cut off or taken prisoners most of the Pompeian fugitives that escaped from the battle of Thapsus, highly deserved to be distinguished in so eminent a manner. After Bocchus's death, Mauritania and the Massælyan Numidia were, in all respects, considered as Roman provinces.

Numismatographia  
Nun.

NUMISMATOGRAPHIA, a term used for the description and knowledge of ancient coins and medals, whether of gold, silver, or brass. See COINS and MEDALS.

NUMITOR, the son of Procas king of Alba, and the brother of Amulius. Procas dying made him and Amulius joint heirs to the crown, on condition of their reigning annually by turns: but Amulius, on getting possession of the throne, excluded Numitor, whose son Lautus he ordered to be put to death, and obliged Rhea Sylvia, Numitor's only daughter, to become a vestal. This princess becoming pregnant, declared that she was with child by the god Mars; and afterwards brought forth Rhemus and Romulus, who at length killed Amulius, and restored Numitor to the throne, 754 B. C.

NUMMUS, a piece of money otherwise called *sestertius*.

NUN, a woman, in several Christian countries, who devotes herself, in a cloister or nunnery, to a religious life. See the article MONK.

There were women, in the ancient Christian church, who made public profession of virginity, before the monastic life was known in the world, as appears from the writings of Cyprian and Tertullian. These, for distinction's sake, are sometimes called *ecclesiastical virgins*, and were commonly enrolled in the canon or matricula of the church. They differed from the monastic virgin chiefly in this, that they lived privately in their fathers houses, whereas the others lived in communities: but their profession of virginity was not so strict as to make it criminal in them to marry afterwards, if they thought fit. As to the consecration of virgins, it had some things peculiar in it: it was usually performed publicly in the church by the bishop. The virgin made a public profession of her resolution, and then the bishop put upon her the accustomed habit of sacred virgins. One part of this habit was a veil, called the *sacrum velamen*; another was a kind of mitre or coronet worn upon the head. At present, when a woman is to be made a nun, the habit, veil, and ring of the candidate are carried to the altar; and she herself, accompanied by her nearest relations, is conducted to the bishop, who, after mass and an anthem, the subject of which is, "that the ought to have her lamp lighted, because the bridegroom is coming to meet her, pronounces the benediction: then she rises up, and the bishop consecrates the new habit, sprinkling it with holy-water. When the candidate has put on her religious habit, she presents herself before the bishop, and sings, on her knees, *Ancilla Christi sum*, &c.; then she receives the veil, and afterwards the ring, by

Nuncio  
||  
Nuremberg

Nuremberg  
||  
Nurling.

by which she is married to Christ; and lastly, the crown of virginity. When she is crowned, an anathema is denounced against all who shall attempt to make her break her vows.

**NUNCIO**, or **NUNTIO**, an ambassador from the pope to some Catholic prince or state, or a person who attends on the pope's behalf at a congress, or an assembly of several ambassadors.

**NUNCUPATIVE**, in the schools, something that is only nominal, or has no existence but in name.

**NUNCUPATIVE Will** or *Testament*, a will made verbally, and not put in writing. See the articles **WILL** and **TESTAMENT**.

**NUNDINA**, a goddess among the ancient Heathens, supposed to have the care of the purification of infants. And because male-infants were purified nine days after their birth, her name is derived from *nonus*, or the ninth, though female-infants were purified the eighth day; which purification was called *lustration* by the Romans.

**NUNDINAL**, (**NUNDINALIS**;) a name which the Romans gave to the eight first letters of the alphabet, used in their calendar.

This series of letters, A, B, C, D, E, F, G, H, is placed and repeated successively from the first to the last day of the year: one of these always expressed the market-days, or the assemblies called *nundine*, quasi *novendina*, because they returned every nine days. The country people, after working eight days successively, came to town the ninth, to sell their several commodities, and to inform themselves of what related to religion and government. Thus the nundinal day being under A on the first, ninth, seventeenth, and twenty-fifth days of January, &c. the letter D will be the nundinal letter of the year following. These nundinals bear a very great resemblance to the dominical letters, which return every eight days, as the nundinals did every nine.

**NUPTIAL RITES**, the ceremonies attending the solemnization of marriage, which are different in different ages and countries.

**NUREMBERG**, an imperial city of Germany, capital of a territory of the same name, situated in E. Long. 11°, N. Lat. 49. 30. It stands on the Regnitz, over which it has several bridges, both of wood and stone, at the bottom of a hill, 60 miles from Augsburg, 87 from Munich, 46 from Wurtzburg, and 50 from Ratibon; and is thought by some to be the Segodonum, and by others the Castrum Noricum, of the ancients. It is large and well built, but not very populous. Its fortifications are a double wall, flanked with towers mounting cannon, and a deep ditch. The magistrates, and most of the inhabitants, are Lutherans. There are a great many churches and chapels in it. In that of St Sebald is a brass monument of the saint; and a picture, representing the creation of the world, by the celebrated Albert Durer, who was a native of the town; but the finest church in the town is that of St Giles. In that of the Holy Ghost are kept most of the jewels of the empire, together with the pretended spear with which our Saviour's side was pierced, a thorn of his crown, and a piece of the manger wherein he was laid. Here are also a great many hospitals, one in particular for foundlings, and another for pilgrims; with a

gymnasium, an anatomical theatre, a granary, a fine public library, the old imperial fortrefs or castle, some remains of the old citadel of the burgraves of Nuremberg, several Latin schools, an academy of painting, a well furnished arsenal, a teutonic house in which the Roman-catholic service is tolerated, and a mint. Mr Keyfler says, there are upwards of 500 streets in it, about 140 fountains, 16 churches, 44 religious houses, 12 bridges, 10 market-places, and 25000 inhabitants; and that its territories, besides the capital and four other towns, contains above 500 villages, and about 160 mills on the Regnitz. The trade of this city, though upon the decline, is still very great, many of its manufactures being still exported to all parts of the world; among which may be reckoned a great variety of curious toys in ivory, wood, and metal. The city has also distinguished itself in the arts of painting and engraving. When the emperor Henry VI. assisted at a tournament in Nuremberg, he raised 38 burghers to the degree of nobility, the descendants of whom are called *patricians*, and have the government of the city entirely in their hands; the whole council, except eight masters of companies, who are summoned only on extraordinary occasions, consisting of them. Among the fine brass cannon in the arsenal, is one that is charged at the breech, and may be fired eight times in a minute; and two that carry balls of eighty pounds. The city keeps, in constant pay, seven companies, consisting each, in time of peace, of 100 men, but, in time of war, of 185; two troops of cuirassiers, each consisting of 85 men; and two companies of invalids. There are also 24 companies of burghers, well armed and disciplined. On the new bridge, which is said to have cost 100,000 guilders, are two pyramids, on the top of one of which is a dove with an olive branch in her bill, and on the other an imperial black eagle. Music also flourishes greatly in Nuremberg; and those who delight in mechanic arts and manufactures, cannot any where better gratify their curiosity. As an imperial city, it has a seat and voice at the diets of the empire and circle, paying to a Roman month one seventh part of the common imposts of the circle, and to the chamber of Wetzlar 812 rix-dollars, each term. The territory belonging to the city is pretty large, containing, besides two considerable forests of pine, called the *Sibald* and *Laurence forests*, several towns and villages.

**NURSERY**, in gardening, is a piece of land set apart for raising and propagating all sorts of trees and plants to supply the garden and other plantations.

**NURSING OF CHILDREN**. See **LACTATIO**.

The following observations are said to be the result *An. Reg.* of long experience. A child, when it comes into the world, is almost a round ball; it is the nurse's part to P. 130<sup>a</sup> assist nature, in bringing it to a proper shape. The child should be laid (the first month) upon a thin matras, rather longer than the child, which the nurse will keep upon her lap, that the child may always lie straight, and only sit up as the nurse slants the matras. To set a child quite upright before the end of the first month, hurts the eyes, by making the white part of the eye appear below the upper eye-lid. Afterwards the nurse will begin to set it up and dance

*Nursing.* it by degrees. The child must be kept as dry as possible.

The clothing should be very light, and not much longer than the child, that the legs may be got at with ease, in order to have them often rubbed in the day with a warm hand or flannel, and in particular the inside of them.

Rubbing a child all over takes off scurf, and makes the blood circulate. The breast should be rubbed with the hands, one way, and the other the other way, night and morning at least.

The ankle-bones and inside of the knees should be rubbed twice a-day; this will strengthen those parts, and make the child stretch its knees and keep them flat, which is the foundation of an erect and graceful person.

A nurse ought to keep a child as little in her arms as possible, lest the legs should be cramped, and the toes turned inwards. Let her always keep the child's legs loose. The oftener the posture is changed, the better.

Tossing a child about, and exercising it in the open air in fine weather, is of the greatest service. In cities, children are not to be kept in hot rooms, but to have as much air as possible.

Want of exercise is the cause of large heads, weak and knotted joints, a contracted breast, which occasions coughs and stuffed lungs, an ill-shaped person, and waddling gait, besides a numerous train of other ills.

The child's flesh is to be kept perfectly clean, by constantly washing its limbs, and likewise its neck and ears; beginning with warm water, till by degrees it will not only bear, but like, to be washed with cold.

Rising early in the morning is good for all children, provided they awake of themselves, which they generally do; but they are never to be waked out of their sleep, and as soon as possible to be brought to regular sleeps in the day.

When laid in bed or cradle, their legs are always to be laid straight.

Children, till they are two or three years old, they must never be suffered to walk long enough at a time to be weary.

Girls might be trained to the proper management of children, if a premium were given in free-schools, workhouses, &c. to those that brought up the finest child to one year old.

If the mother cannot suckle the child, get a wholesome cheerful woman, with a young milk, who has been used to tend young children. After the first six months, small broths, and innocent foods of any kind, may do as well as living wholly upon milk.

A principal thing to be always attended to is, to give young children constant exercise, and to keep them in a proper posture.

With regard to the child's dress in the day, let it be a shirt; a petticoat of fine flannel, two or three inches longer than the child's feet, with a dimitytop (commonly called a *bodice-coat*), to tie behind; over that a surcingle made of fine buckram, two inches broad, covered over with tatten or fine ticken, with a ribbon fastened to it to tie it on, which answers every purpose of stays, and has none of their inconveniences.

Over this put a robe, or a slip and frock, or whatever you like best; provided it is fastened behind, and not much longer than the child's feet, that their motions may be strictly observed.

Two caps are to be put on the head, till the child has got most of its teeth.

The child's dress for the night may be a shirt, a blanket to tie on, and a thin gown to tie over the blanket.

**NUSANCE**, in law, a thing done to the annoyance of another.

Nuances are either public or private.—A public nuisance is an offence against the public in general, either by doing what tends to the annoyance of all the king's subjects, or by neglecting to do what the common good requires: in which case, all annoyances and injuries to streets, highways, bridges, and large rivers, as also disorderly ale-houses, bawdy-houses, gaming-houses, stages for rope-dancers, &c. are held to be common nuisances.—A private nuisance is, when only one person or family is annoyed by the doing of any thing; as where a person stops up the light of another's house, or builds in such a manner that the rain falls from his house upon his neighbour's.

**NUT**, among botanists, denotes a **PERICARPUM** of an extraordinary hardness, inclosing a kernel or seed.

**NUTATION**, in astronomy, a kind of tremulous motion of the axis of the earth, whereby, in each annual revolution, it is twice inclined to the ecliptic, and as often returns to its former position.

**NUT-HATCH**, in ornithology. See **SITTA**.

**NUTMEG**, the kernel of a large fruit, not unlike the peach.

The nutmeg, as we receive it, is of a roundish or oval figure, of a tolerably compact and firm texture, but easily cut with a knife, and falling to pieces on a smart blow. Its surface is not smooth, but furrowed with a number of wrinkles, running in various directions, though principally longitudinally. It is of a greyish-brown colour on the outside, and of a beautiful variegated hue within, being marbled with brown and yellow variegations, running in perfect irregularity through its whole substance. It is very unctuous and fatty to the touch, when powdered; and is of an extremely agreeable smell, and of an aromatic taste.

There are two kinds of nutmeg in the shops; the one called by authors the *male*, and the other the *female*. The female is the kind in common use, and is of the shape of an olive: the male is long and cylindrical, and has less of the fine aromatic flavour than the other; so that it is much less esteemed, and people who trade largely in nutmegs will seldom buy it. The longer *male nutmeg*, as we term it, is called by the Dutch the *ovoid nutmeg*. It is always distinguishable from the others, as well by its want of fragrance, as by its shape: it is very subject to be worm-eaten; and is strictly forbid, by the Dutch, to be packed up among the other, because it will give occasion to their being worm-eaten too, by the insects getting from it into them, and breeding in all parts of the parcel.

The largest, heaviest, and most unctuous of the nutmegs are to be chosen, such as are of the shape of



**Nutmeg, Nutrition.** an olive, and of the most fragrant smell. The Dutch import them from the East-Indies.

The tree which produces the nutmeg grows only in the Banda islands. It has a pithy wood, an ash-coloured bark, and flexible branches. The leaves are produced in pairs upon one single stem; and, when bruised, emit an agreeable odour. The fruit succeeds the flowers, which resemble those of the cherry-tree. It is of the size of an egg, and of the colour of an apricot. The outer rind is very thick, and resembles that of our nuts as they hang upon the tree, opening in the same manner when ripe, and discovering the nutmeg covered with its mace. It is then time to gather it, to prevent the mace or flower of the nutmeg from growing dry, and the nutmeg from losing that oil which preserves it, and in which its excellence consists. Those that are gathered before they are perfectly ripe, are preserved in vinegar or sugar, and admired only in Asia.

This fruit requires nine months to bring it to perfection. After it is gathered, the outer rind is stripped off, and the mace separated from it, and laid in the sun to dry. The nuts require more preparation.—They are spread upon hurdles, and dried for six weeks by a slow fire, in sheds erected for that purpose. They are then separated from the shell, and thrown into lime-water, as a necessary preservative against worms.

Nutmeg is greatly used in our foods, and is of excellent virtue as a medicine; it is a good stomachic, promotes digestion, and strengthens the stomach. It also stops vomiting; is an excellent remedy in fistulas; and is happily joined with rhubarb, and other medicines, in diarrhæas. It is observed to have a soporific virtue, and to exert it too strongly if taken in immoderate quantities. It has a considerable degree of astringency; and given, after toasting before the fire till thoroughly dry and crumbly, it has been sometimes known alone to cure diarrhæas.

**NUTRITION**, in the animal-economy, is the repairing the continual loss which the different parts of the body undergo. The motion of the parts of the body, the friction of these parts with each other, and especially the action of the air, would destroy the body entirely, if the loss was not repaired by a proper diet, containing nutritive juices; which being digested in the stomach, and afterwards converted into chyle, mix with the blood, and are distributed through the whole body for its nutrition.

In young persons, the nutritive juices not only serve to repair the parts that are damaged, but also to increase them, which is called *growth*.

In grown persons, the cuticle is every-where constantly desquamating, and again renewing: and in the same manner the parts rubbed off, or otherwise separated from the fleshy parts of the body, are soon supplied with new flesh; a wound heals, and an emaciated person grows plump and fat.

Buffon, in order to account for nutrition, supposes the body of an animal or vegetable to be a kind of mould, in which the matter necessary to its nutrition is modelled and assimilated to the whole. But (continues he) of what nature is this matter which an animal or vegetable assimilates to its own substance? What power is it that communicates to this matter

the activity and motion necessary to penetrate this mould? and, if such a force exist, would it not be by a similar force that the internal mould itself might be reproduced?

**Nux  
Nyctanthes**

As to the first question, he supposes that there exists in nature an infinite number of living organic parts, and that all organized bodies consist of such organic parts; that their production costs nature nothing, since their existence is constant and invariable; so that the matter which the animal or vegetable assimilates to its substance, is an organic matter, of the same nature with that of the animal or vegetable, which consequently may augment its volume without changing its form or altering the quality of the substance in the mould.

As to the second question: There exist (says he) in nature certain powers, as that of gravity, that have no affinity with the external qualities of the body, but act upon the most intimate parts, and penetrate them throughout, and which can never fall under the observation of our senses.

And, as to the third question, he answers, that the internal mould itself is reproduced, not only by a similar power, but it is plain that it is the very same power that causes the unfolding and reproduction thereof: for it is sufficient (proceeds he), that in an organized body that unfolds itself, there be some part similar to the whole, in order that this part may one day become itself an organized body, altogether like that of which it is actually a part.

**NUX PISTACHIA.** See **PISTACHIA**.

**Nux Vomica**, a flat, compressed, round fruit, about the breadth of a shilling, brought from the East Indies. It is found to be a certain poison for dogs, cats, &c. and it is not to be doubted that it would also prove fatal to mankind. Its surface is not much corrugated; and its texture is firm like horn, and of a pale greyish-brown colour.

**NYCHTHEMERON**, the natural day, or day and night, which together make 24 hours.

**NYCTALOPIA.** See **MEDICINE**, n° 456.

**NYCTANTHES**, **ARABIAN JASMINE**; a genus of the monogynia order, belonging to the diandria class of plants. There are five species; the most remarkable of which are, 1. The arbor tristis, or sorrowful tree. This tree, or shrub, the *pariatacu* of the Bramins, grows naturally in fandy places in India, particularly in the islands of Ceylon and Java, where it is produced in great abundance, and attains the height of 18 or 20 feet. It rises with a four-cornered stem, bearing leaves that are oval, and taper to a point. They stand opposite, on short foot-stalks; are of a shining brownish-green on the upper-side, a more vivid green on the under, and of a taste that is astringent and somewhat bitter. From the middle-rib, on the under-surface of the leaves, proceed on both sides a number of costule, or smaller ribs, which run nearly to the margin, and mark the surface with the impression of their arched furrows. The flowers, which are white, and highly odoriferous, having a sweet delectable smell emulating the best honey, consist of one petal deeply divided into eight parts, which are narrower towards the stalk, and dilated towards the summit. They stand upon foot-stalks, which emerge from the origin of the leaves; are rigid, obliquely raised.

Nycticorax

Nymph.

raised towards the top, grow opposite in pairs, and are divided into three short lesser branches, which each supports five flowers placed close together, without partial foot-stalks. The fruit is dry, capsular, membranaceous, and compressed.

It is generally asserted of this plant, that the flowers open in the evening, and fall off the succeeding day. Fabricius and Paludanus, however, restrict the assertion, by affirming, from actual observation, that this effect is found to take place only in such flowers as are immediately under the influence of the solar rays. Grinnius remarks in his *Laboratorium Ceylonicum*, that the flowers of this tree afford a fragrant water, which is cordial, refreshing, and frequently employed with success in inflammations of the eyes. The tube of the flower, when dried, has the smell of saffron; and, being pounded and mixed with Sanders-wood, is used by the natives of the Malabar coast for imparting a grateful fragrant to their bodies, which they rub or anoint with the mixture.

2. The sambac, noted, like the other species, for the fragrant of its flowers, is a native likewise of India; and is cultivated in our hoves, where it generally rises with a twining stem, to the height of 18 or 20 feet. The leaves are opposite, simple, and entire; but in different parts of the plant assume different forms: the lower leaves being heart-shaped and blunt; the upper, oval and sharp. The flowers are white, inexpressibly fragrant, and generally appear with us in the warm summer-months. Strong loam is its proper soil. There is a variety of this species with a double flower, which is much larger and more fragrant than the former.

NYCTICORAX, in ornithology, the night-raven; a species of ARDEA.

NYLAND, a province of Finland in Sweden, lying on the gulf of Finland, to the west of the province of Carelia.

NYMPH, in mythology, an appellation given to certain inferior goddesses, inhabiting the mountains, wood, waters, &c. said to be the daughters of Oceanus and Tethys. All the universe was represented as full of these nymphs, who are distinguished into several ranks or classes. The general division of them is into celestial and terrestrial; the former of which were called *urania*, and were supposed to be intelligences that governed the heavenly bodies or spheres. The terrestrial nymphs, called *epigia*, presided over the several parts of the inferior world; and were divided into those of the water, and those of the earth. The nymphs of the water were the *oceanitides*, or nymphs of the ocean; the *mercids*, the nymphs of the sea; the *naiads* and *ephyriades*, the nymphs of the fountains; and the *limniades*, or nymphs of the lakes. The nymphs of the earth were the *oreades*, or nymphs of the mountains; the *naxæ*, nymphs of the meadows; and the *dryads* and *hamadryads*, who were nymphs of the forests and groves. Besides these, we meet with nymphs who took their names from particular countries, rivers, &c. as the *cithæroniades*, so called from mount Cithæron in Bœotia; the *dodonides*, from Dodona; *tiberiades*, from the Tiber, &c.—Goats were sometimes sacrificed to the nymphs; but their constant offerings were milk, oil, honey, and wine.

NYMPH, among naturalists, that state of winged-

insects between their living in the form of a worm, and Nymphæ, their appearing in the winged or molt perfect state.

Nym-  
phæum.

The eggs of insects are first hatched into a kind of worms, or maggots; which afterwards pass into the nymph-state, surrounded with shells or cases of their own skins: so that, in reality, these nymphs are only the embryo insects, wrapped up in this covering; from whence they at last get loose, though not without great difficulty.

During this nymph-state the creature loses its motion. Swammerdam calls it *nympha aurelia*, or simply *aurelia*; and others give it the name of *chrysalis*, a term of the like import. See the article CHRYSALIS.

NYMPHÆ, in anatomy, two membranaceous parts, situated on each side the rima. They are of a red colour, and cavernous structure, somewhat resembling the wattles under a cock's throat. They are sometimes smaller, sometimes larger; and are continuous to the præputium of the clitoris, and joined to the interior side of the labia.

NYMPHÆA, the WATER-LILY; a genus of the monogynia order, belonging to the polyandria class of plants. There are four species; of which the most remarkable are, 1, 2. The lutea and alba, or yellow and white water-lilies; both of which are natives of Britain, growing in lakes and ditches. Linnæus tells us, that swine are fond of the leaves and roots of the former; and that the smoke of it will drive away crickets and blatta, or cock-roaches, out of houses.—The root of the second has an alkering and bitter taste, like those of most aquatic plants that run deep into the mud. The Highlanders make a dye with it of a dark chestnut colour. 3. In the East and West India grows a species of this plant, named *nelumbo* by the inhabitants of Ceylon. The leaves which rest upon the surface of the water, are smooth, undivided, perfectly round, thick, target-shaped, and about one foot and a half in diameter. The footstalk of the leaves is prickly; and inserted, not into their base, or margin, as in most plants, but in the centre of the lower disk or surface. From this centre, upon the upper surface, issue, like rays, a great number of large ribs, or nerves, which towards the circumference are divided and subdivided into a small number of very minute parts. The flowers are large, flesh-coloured, and consist of numerous petals, disposed, as in the other species of water-lily, in two or more rows. The seed-veffel is shaped like a top, being broad and circular above, narrow and almost pointed below. It is divided into several distinct cells, which form so many large round holes upon the surface of the fruit; each containing a single seed.—With the flower of this plant, which is sacred among the heathens, they adorn the altars of their temples: they paint their gods sitting upon it; and make use of such pictures to animate the minds of the pious on their death-bed, and to raise their affections to heaven. The stalks, which are used as a pot-herb, are of a wonderful length. The root is very long, extends itself transversely, is of the thickness of a man's arm, jointed and fibrous, with long intervals betwixt the joints. The fibres surround the joints in verticilli, or whorls.

NYMPHEUM, in antiquity, a public hall magnificently decorated, for entertainment, &c. and where those who wanted convenience at home held their marriage-

Nyon  
Nyssa.

riage-feasts, whence the name.

NYON, a considerable town of Switzerland, in the canton of Bern, and capital of a bailiwick of the same name, with a castle. There are a great many Roman inscriptions here; and it is a trading place, feated in a good country, near the lake of Geneva. E. Long. 5. 10. N. Lat. 46. 24.

NYSLÖT, a strong town of Ruffia, in Livonia, with a castle; feated on the river Narva, among large marshes. E. Long. 26. 55. N. Lat. 58. 46.

NYSSA, a genus of the order of dioecia, belonging

to the polygamia class of plants. There is but one species, viz. The aquatica, or water-tupelo-tree. This has a large trunk, especially near the ground, and grows very tall. The leaves are broad, and irregularly notched. The flowers come out from the sides of the branches, on footstalks of three inches long, and are of a greenish colour. The grain of the wood is soft and spongy; but the roots much more so, approaching near to the consistence of cork; and are used for the purposes of cork in Carolina, where these trees are natives. They grow in wet places, and usually in the shallow parts of rivers.

Nydot.

## O

O,  
Oak.

**O**, The 14th letter and fourth vowel of our alphabet; pronounced as in the words *nose, rose,* &c.

The found of this letter is often so soft as to require it double, and that chiefly in the middle of words; as *goose, reproof,* &c. And in some words this *oo* is pronounced like *u* short, as in *food, blood,* &c.

As a numeral, O is sometimes is used for 11; and with a dash over it thus, *Ō*, for 11,000.

In the notes of the ancients, O. CON. is read *opus conductum*; O. C. Q. *opera confilique*; O. D. M. *opera, donum, manus*; and O. LO. *opus locatum*.

In music, the O, or rather a circle, or double CO, is a note of time, called by us a *semi-breve*; and by the Italians, *circolo*. The O is also used as a mark of triple time, as being the most perfect of all figures. See TRIPLE.

OAK, in botany. See QUERCUS.

*Oak-Leaves.* The uses of oak-bark in tanning, and in hot-beds, is generally known. For the latter of these purposes, however, oak-leaves are now found to answer equally well, or rather better. In the notes to Dr Hunter's edition to Evelyn's Treatise on Forest-trees, we find the following directions for their use by W. Speechly. The leaves are to be raked up as soon as possible after they fall from the trees. When raked into heaps, they should immediately be carried into some place near the hot-houses, where they may lie to couch. Mr Speechly says it was his custom to fence them round with charcoal hurdles, or any thing else, to keep them from being blown about the garden in windy weather. In this place they tread them well, and water them in case they happen to have been brought in dry. The heap is made six or seven feet thick, and covered over with old mats, or any thing else, to prevent the upper leaves from being blown away. In a few days the heap will come to a strong heat. For the first year or two in which he used these leaves, our author did not continue them in the heap longer than ten days or a fortnight: but by this method of management they settled so much when brought to the hot-house, that a supply was very soon required; and he afterwards found, that it was proper to let them remain five or six weeks in the heaps before they are brought to the hot-house. In getting them into the pine-pits, if they appear dry, they are

to be watered, and again trodden down exceedingly well, in layers, till the pits are quite full. The whole is then covered with tan-bark, to the thickness of two inches, and well trodden down, till the surface becomes smooth and even. On this the pine-pots are to be placed in the manner they are to stand, beginning with the middle row first, and filling up the spaces between the pots with tan. In this manner we are to proceed to the next row, till the whole be finished; and this operation is performed in the same manner as when tan only is used. The leaves require no further trouble through the whole season; as they will retain a constant and regular heat for 12 months without stirring or turning; and our author informs us, that if he may judge from their appearance when taken out, (being always entire and perfect), it is probable they would continue their heat through a second year; but, as an annual supply of leaves is easily obtained, the experiment is hardly worth making. After this, the pines will have no occasion to be moved, but at stated times of their management, viz. at the shifting them in their pots, &c. when at each time a little fresh tan should be added to make up the deficiency arising from the settling of the beds; but this will be inconsiderable, as the leaves do not settle much after their long couching. During the first two years of our author's practice he did not use any tan, but plunged the pine-pots into the leaves, and just covered the surface of the beds, when finished, with a little saw-dust, to give it a neatness. This method, however, was attended with one inconvenience; for by the caking of the leaves they shrank from the sides of the pots, whereby they became exposed to the air, and at the same time the heat of the beds was permitted to escape.

Oak.

"Many powerful reasons, says Mr Speechly, may be given why oak-leaves are preferable to tanner's-bark.

"1. They always heat regularly; for during the whole time that I have used them, which is near seven years, I never once knew of their heating with violence; and this is so frequently the case with tan, that I affirm, and indeed it is well known to every person conversant in the management of the hot-house, that pines suffer more from this one circumstance, than all the other accidents put together, insects excepted.

Whca

When this accident happens near the time of their fruiting, the effect is soon seen in the fruit, which is exceedingly small and ill-shaped. Sometimes there will be little or no fruit at all; therefore gardeners who make use of tan only for their pines, should be most particularly careful to avoid an over-heat at that critical juncture,—the time of shewing the fruit.

" 2. The heat of oak-leaves is constant; whereas tanner's bark generally turns cold in a very short time after its furious heat is gone off. This obliges the gardener to give it frequent turnings in order to promote its heating. These frequent turnings, not to mention the expence, are attended with the worst consequences; for by the continual moving of the pots backwards and forwards, the pines are exposed to the extremes of heat and cold, whereby their growth is considerably retarded; whereas, when leaves are used, the pines will have no occasion to be moved but at the times of potting, &c. The pines have one peculiar advantage in this undisturbed situation; their roots grow through the bottoms of the pots, and mat among the leaves in a surprising manner. From the vigour of the plants when in this situation, it is highly probable that the leaves, even in this state, afford them an uncommon and agreeable nourishment.

" 3. There is a saving in point of expence; which is no inconsiderable object in places where tan cannot be had but from a great distance.

" 4. The last ground of preference is, that decayed leaves make good manure; whereas rotten tan is experimentally found to be of no value. I have often tried it both on sand and clay, and on wet and dry land; and never could discover, in any of my experiments, that it deserved the name of a manure; whereas decayed leaves are the richest, and of all others the most proper manure for a garden. Leaves mixed with dung make excellent hot-beds; and I find that beds compounded in this manner, preserve their heat much longer than when made entirely with dung; and in both cases, the application of leaves will be a considerable saving of dung, which is a circumstance on many accounts agreeable."

OAK *Saw-dust* is now found to answer the purposes of tanning as well, at least, as the bark. See TANNING.

OAK of *Jerusalem*. See CHENOPODIUM.

OAKAM, old ropes untwisted and pulled out into loose hemp, in order to be used in caulking the seams, tree-nails, and bends of a ship, for stopping or preventing leaks.

OAKHAMPTON, a town of Devonshire, which sends two members to parliament; situated in E. Long. 1. 47. N. Lat. 45. 4.

OAR, a long piece of timber, flat at one end, and round or square at the other, and which being applied to the side of a floating-vessel, serves to make it advance upon the water.

That part of the oar which is out of the vessel, and which enters into the water, is called the *blade*, or *wash*, *flat*; and that which is within-board is termed the *hoop*, whose extremity being small enough to be grasped by the rowers, or persons managing the oars, is called the *handle*.

To push the boat or vessel forwards by means of this instrument, the rowers turn their backs forward,

and, dipping the blade of the oar in the water, pull the handle forward so that the blade at the same time may move aft in the water: but since the blade cannot be so moved, without striking the water, this impulsion is the same, as if the water were to strike the blade from the stern towards the head: the vessel is therefore necessarily moved according to this direction. Hence it follows, that she will advance with the greater rapidity, by as much as the oar strikes the water more forcibly. Thus it is evident, that an oar acts upon the side of a boat or vessel like a lever of the second class, whose fulcrum is the station upon which the oar rests on the boat's gunnel. In large vessels, this station is usually called the *row-port*; and in lights and boats it is always termed the *row lock*.

OAT, in botany. See AVENA.

OATH, is a solemn affirmation, in which the persons sworn invoke the Almighty to witness that their testimony is true; renouncing all claim to his mercy, and calling for vengeance, if it be false.

Coronation-OATH. See KING.

OBADIAH, or the *Prophecy of OBADIAH*, a canonical book of the Old Testament, which is contained in one single chapter; and is partly an invective against the cruelty of the Ebonites, who mocked and derided the children of Israel, as they passed into captivity, and with other enemies, their confederates, invaded and oppressed those strangers, and divided the spoil amongst themselves; and partly a prediction of the deliverance of Israel, and of the victory and triumph of the whole church over her enemies.

OBELISK, in architecture, a truncated, quadrangular, and slender pyramid, raised as an ornament, and frequently charged either with inscriptions or hieroglyphics.

Obelisks appear to be of very great antiquity, and to be first raised to transmit to posterity precepts of philosophy, which were cut in hieroglyphical characters: afterwards they were used to immortalize the great actions of heroes, and the memory of persons beloved. The first obelisk mentioned in history was that of Ramases king of Egypt, in the time of the Trojan war, which was 40 cubits high. Ptolemy another king of Egypt, raised one of 45 cubits: and Ptolemy Philadelphus, another of 88 cubits, in memory of Arsinoë. Augustus erected one at Rome in the Campus Martius, which served to mark the hours on an horizontal dial, drawn on the pavement. They were called by the Egyptian priests the *fingers of the sun*, because they were made in Egypt also to serve as styles or gnomons to mark the hours on the ground. The Arabs still call them *Pharaoh's needles*: whence the Italians call them *aguglia*, and the French *aiguilles*.

OBJECT, in philosophy, something apprehended or presented to the mind by sensation or imagination. See METAPHYSICS.

OBJECT-Glass of a *Telescope*, or *Microscope*, the glass placed at the end of the tube which is next the object. See OPTICS.

OBJECTION, something urged to overthrow a position, or a difficulty raised against an allegation or proposition of a person we are disputing withal.

OBJECTIVE, is used in the schools, in speaking of a thing which exists no otherwise than as an object known.

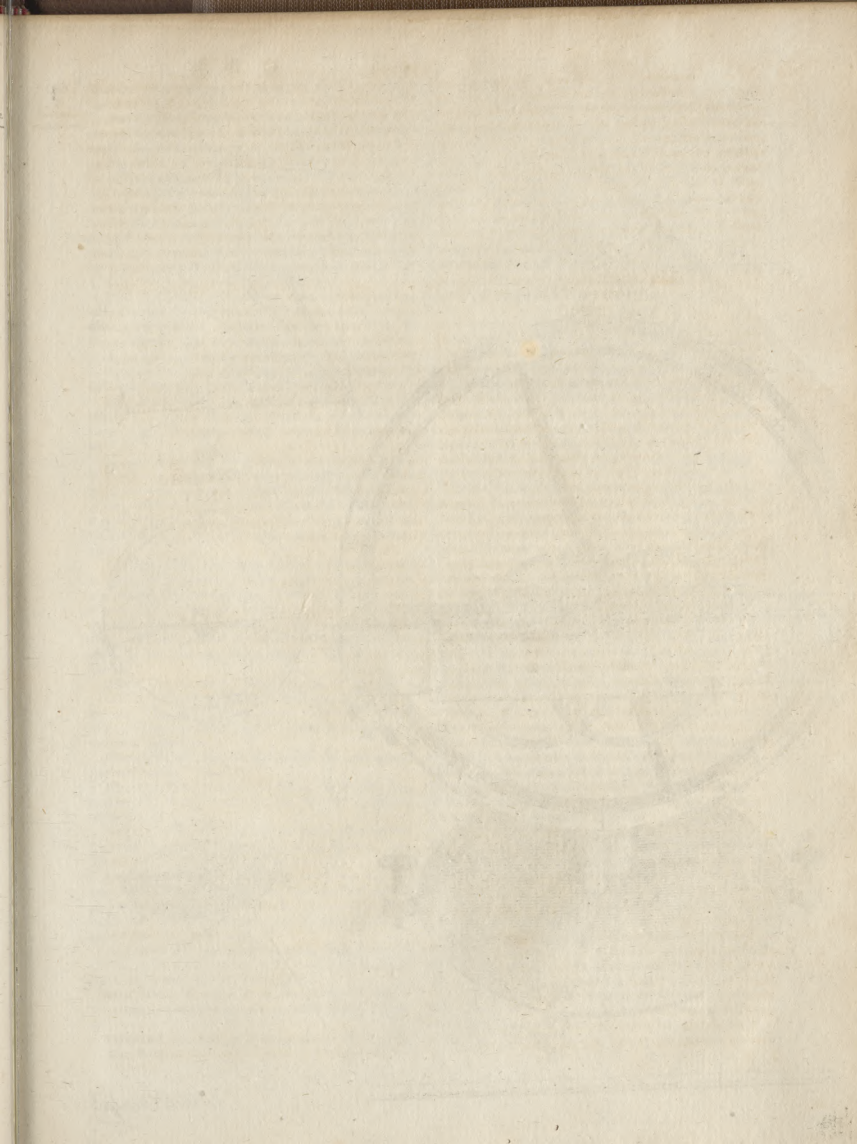


Fig. 2.

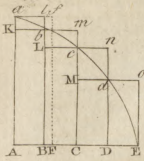


Fig. 1.

DIPPING NEEDLE.

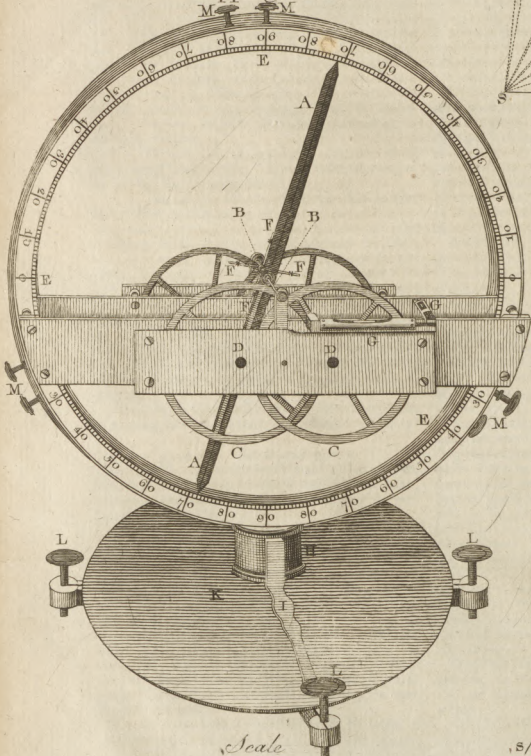


Fig. 3.

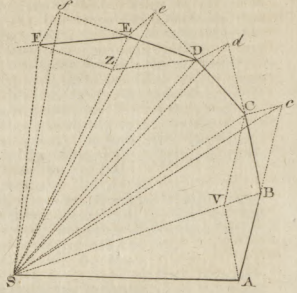
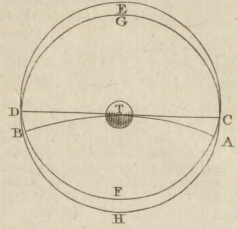
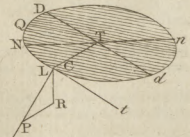


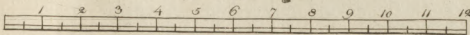
Fig. 4  
NODES  
N<sup>o</sup> 1.



N<sup>o</sup> 2.



Scale



**Obit** known. The existence of such a thing is said to be objective.

**Obolus.**

**OBIT**, (Lat.) signifies a funeral solemnity, or office for the dead, most commonly performed when the corpse lies in the church uninterred: Also the anniversary office, (2 Cro. 51 Dyer 313). The anniversary of any person's death was called the *obit*; and to observe such day with prayers and alms, or other commemoration, was the keeping of the obit. In religious houses they had a register, wherein they entered the obits or obitual days of their founders and benefactors; which was thence termed the *obituary*. The tenure of obit or chantry lands is taken away and extinct by 1 Edw. VI. c. 14. and 15 Car. II. c. 9.

**OBLATI**, in church-history, were secular persons, who devoted themselves and their estates to some monastery, into which they were admitted as a kind of lay-brothers. The form of their admission, was putting the bell-ropes of the church round their necks, as a mark of fervitude. They wore a religious habit, but different from that of the monks.

**OBLIGATION**, in general, denotes any act whereby a person becomes bound to another to do something; as to pay a sum of money, be surety, or the like.

Obligations are of three kinds, *viz.* natural, civil, and mixed. Natural obligations are entirely founded on natural equity; civil obligation, on civil authority alone, without any foundation in natural equity; and mixed obligations are those which, being founded on natural equity, are farther enforced by a civil authority.

In a legal sense, obligation signifies a bond, wherein is contained a penalty, with a condition annexed for the payment of money, &c. The difference between it and a bill is, that the latter is generally without a penalty or condition, though it may be made obligatory; and obligations are sometimes by matter of record, as statutes and recognizances. See the article **BOND**.

**MORAL OBLIGATION**. See **MORALS**, n° 36—40.

**OBLIQUE**, in geometry, something oblique, or that deviates from the perpendicular. Thus an oblique angle, is either an acute or obtuse one, *i. e.* any angle except a right one.

**OBLIQUE Cases**, in grammar, are all the cases except the nominative. See **CASE**.

**OBLIQUE Lines**, that which, falling on another line, makes oblique angles with it, *viz.* one acute, and the other obtuse.

**OBLIQUE Planes**, in dialling, are those which decline from the zenith, or incline towards the horizon. See **DIAL**.

**OBLIQUE Sailing**, in navigation, is when a ship sails upon some rhumb between the four cardinal points, making an oblique angle with the meridian; in which case, the continually changes both latitude and longitude. See **NAVIGATION**, §. 6.

**OBLIQUUS**, in anatomy, a name given to several muscles, particularly in the head, eyes, and abdomen. See **ANATOMY**, *Table of the Muscles*.

**OBLONG**, in general, denotes a figure that is longer than broad: such is a parallelogram, ellipsis, &c.

**OBOLUS**, an ancient silver money of Athens, the

sixth part of a drachma; worth somewhat more than penny-farthing Sterling.—The word comes from the Greek *ὀβολός*, of *ὀβελός*, “spit, or broach;” either because it bore such an impression; or because, according to Eustachius, it was in form thereof. But those now in the cabinets of the antiquaries are round.

**OBOLUS**, in medicine, is used for a weight of ten grains, or half a scruple.

**OBRECHT** (Ulric), a learned German, born of a noble family at Strasburg in 1646, where he filled the chairs of civil law and history with great distinction. He was of the Protestant religion; but when Lewis XIV. made himself master of Strasburg, and went there with his court, he was prevailed on to change; and accordingly abjured in 1684, and put his instrument into the hands of Bossuet bishop of Meaux. The next year the king nominated him to preside in his name in the senate of Strasburg, with the title of praetor royal, in imitation of the ancient Romans; from which time Mr Obrecht applied himself entirely to public affairs. He was the editor, translator, and writer, of several learned works; and died in 1701.

**OBREPTITIOUS**, an appellation given to letters patent, or other instruments, obtained of a superior by surprise, or by concealing from him the truth.

**OBSCURE**, something that is dark and reflects little light, or that is not clear and intelligible.

**OBSECRATION**, in rhetoric, a figure whereby the orator implores the assistance of God or man.

**OBSEQUENS** (Julius), a Latin writer, conjectured to have lived before the emperor Honorius's reign. He made a collection of the prodigies which Livy related in his history. There are several editions of those remains. Lycosthenes endeavoured to supply what was wanting in the original.

**OBSEQUIES**, the same with funeral solemnities. See **FUNERAL**.

**OBSERVATION**, among navigators, signifies the taking the sun's or the stars meridian altitude, in order thereby to find the latitude.

**OBSERVATORY**, a place destined for observing the heavenly bodies; being generally a building erected on some eminence, covered with a terrace for making astronomical observations.

The more celebrated observatories are, 1. The Greenwich observatory, built in 1676, by order of Charles II. at the solicitation of Sir Jonas Moore and Sir Christopher Wren; and furnished with the most accurate instruments, particularly a noble sextant of seven feet radius, with telescopic sights.

2. The Paris observatory, built by the order of Louis XIV. in the Faubourg, St Jacques.

It is a very singular, but withal a very magnificent building, the design of Monsieur Perault: it is eighty feet high; and at top is a terrace.

The difference in longitude between this and the Greenwich observatory is 2° 20' west.

In it is a cave, or cellar, of 170 feet descent, for experiments that are to be made far from the sun, &c. particularly such as relate to congelations, refrigerations, indurations, conservations, &c.

3. Tycho Brahe's observatory, which was in the little island Wreen, or Scarlet Island, between the coasts of Schonen and Zealand, in the Baltic. It was erected and furnished with instruments at his own ex-

Obolus  
||  
Observatory

Observatory pence, and called by him *Uraniburg*. Here he spent twenty years in observing the stars; the result is his catalogue.

4. Pekin observatory. Father Le Compte describes a very magnificent observatory, erected and furnished by the late emperor of China, in his capital, at the intercession of some Jesuit missionaries, principally Father Verbeist, whom he made his chief observer.—The instruments are exceedingly large; but the division less accurate, and the contrivance in some respects less commodious, than that of the Europeans. The chief are, An armillary zodiacal sphere of six feet diameter; an equinoctial sphere of six feet diameter; an azimuthal horizon of six feet diameter; a large quadrant six feet radius; a sextant eight feet radius; and a celestial globe six feet diameter.

5. Bramins observatory at Benares. Of this Sir Robert Barker gives the following account, Phil. Trans. Vol. LXVII. p. 598. “ Benares in the East Indies, one of the principal seminaries of the Bramins or priests of the original Gentoos of Hindoostan, continues still to be the place of resort of that sect of people; and there are many public charities, hospitals, and pagodas, where some thousands of them now reside. Having frequently heard that the ancient Bramins had a knowledge of astronomy, and being confirmed in this by their information of an approaching eclipse both of the sun and moon, I made inquiry, when at that place in the year 1772, among the principal Bramins, to endeavour to get some information relative to the manner in which they were acquainted of an approaching eclipse. The most intelligent that I could meet with, however, gave me but little satisfaction. I was told, that these matters were confined to a few, who were in possession of certain books and records; some containing the mysteries of their religion; and others the tables of astronomical observations, written in the Skanskirrit language, which few understood but themselves: that they would take me to a place which had been constructed for the purpose of making such observations as I was inquiring after, and from whence they supposed the learned Bramins made theirs. I was then conducted to an ancient building of stone, the lower part of which, in its present situation, was converted into a stable for horses, and a receptacle for lumber; but, by the number of court-yards and apartments, it appeared that it must once have been an edifice for the use of some public body of people. We entered this building, and went up a stair-case to the top of a part of it, near to the river Ganges, that led to a large terrace, where, to my surprize and satisfaction, I saw a number of instruments yet remaining, in the greatest preservation, stupendously large, immovable from the spot, and built of stone, some of them being upwards of 20 feet in height; and, although they are said to have been erected 200 years ago, the graduations and divisions on the several arcs appeared as well cut, and as accurately divided, as if they had been the performance of a modern artist. The execution in the construction of these instruments exhibited a mathematical exactness in the fixing, bearing, sitting of the several parts, in the necessary and sufficient supports to the very large stones that composed them, and in the joining and fastening each in-

to the other by means of lead and iron.

“ The situation of the two large quadrants of the instrument marked A in the plate, whose radius is nine feet two inches, by their being at right angles with a gnomon at twenty-five degrees elevation, are thrown into such an oblique situation as to render them the most difficult, not only to construct of such a magnitude, but to secure in their position for so long a period, and affords a striking instance of the ability of the architect in their construction: for, by the shadow of the gnomon thrown on the quadrants, they do not appear to have altered in the least from their original position; and so true is the line of the gnomon, that, by applying the eye to a small iron ring of an inch diameter at one end, the sight is carried through three others of the same dimension, to the extremity at the other end, distant 38 feet 8 inches, without obstruction; such is the firmness and art with which this instrument has been executed. This performance is the more wonderful and extraordinary when compared with the works of the artificers of Hindoostan at this day, who are not under the immediate direction of an European mechanic; but arts appear to have declined equally with science in the east.

“ Lieutenant-colonel Archibald Campbell, at that time chief engineer in the East India Company's service at Bengal, made a perspective drawing of the whole of the apparatus that could be brought within his eye at one view; but I lament he could not represent some very large quadrants, whose radii were about twenty feet, they being on the side from whence he took his drawing. Their description however is, that they are exact quarters of circles of different radii, the largest of which I judged to be 20 feet, constructed very exactly on the sides of stone-walls built perpendicular, and situated, I suppose, in the meridian of the place: a brass pin is fixed at the centre or angle of the quadrant, from whence, the Bramin informed me, they stretched a wire to the circumference when an observation was to be made; from which it occurred to me, the observer must have moved his eye up or down the circumference, by means of a ladder or some such contrivance, to raise and lower himself, until he had discovered the altitude of any of the heavenly bodies in their passage over the meridian, so expressed on the arcs of these quadrants: these arcs were very exactly divided into nine large sections; each of which again into ten, making ninety lesser divisions or degrees; and those also into twenty, expressing three minutes each, of about two-tenths of an inch asunder; so that it is probable, they had some method of dividing even these into more minute divisions at the time of observation.

“ My time would only permit me to take down the particular dimensions of the most capital instrument, or the greater equinoctial sun-dial, represented by figure A, which appears to be an instrument to express solar time by the shadow of a gnomon upon two quadrants, one situated to the east, and the other to the west of it; and indeed the chief part of their instruments at this place appear to be constructed for the same purpose, except the quadrants, and a brass instrument that will be described hereafter.

“ Figure B is another instrument for the purpose of determining the exact hour of the day by the shadow



**Observatory** **Obliidianus** drow of a gnomon, which stands perpendicular to and in the centre of a flat circular stone, supported in an oblique situation by means of four upright stones and a cross-piece; so that the shadow of the gnomon, which is a perpendicular iron rod, is thrown upon the division of the circle described on the face of the flat circular stone.

"Figure c is a brass circle, about two feet diameter, moving vertically upon two pivots between two stone pillars, having an index or hand turning round horizontally on the centre of this circle, which is divided into 360 parts; but there are no counter-divisions on the index to subdivide those on the circle. This instrument appears to be made for taking the angle of a star at setting or rising, or for taking the azimuth or amplitude of the sun at rising or setting.

"The use of the instrument, figure d, I was at a loss to account for. It consists of two circular walls; the outer of which is about forty feet diameter, and eight feet high; the wall within about half that height, and appears intended for a place to stand on to observe the divisions on the upper circle of the outer wall, rather than for any other purpose; and yet both circles are divided into 360 degrees, each degree being subdivided into twenty lesser divisions, the same as the quadrants. There is a door-way to pass into the inner circle, and a pillar in the centre, of the same height with the lower circle, having a hole in it, being the centre of both circles, and seems to be a socket for an iron rod to be placed perpendicular into it. The divisions on these, as well as all the other instruments, will bear a nice examination with a pair of compasses.

"Figure e is a smaller equinoctial sun-dial, constructed upon the same principle as the large one A.

"I cannot quit this subject without observing, that the Bramins, without the assistance of optical glasses, had nevertheless an advantage unexperienced by the observers of the more northern climates. The serenity and clearness of the atmosphere in the nighttime in the East Indies, except at the seasons of changing the monsoons or periodical winds, is difficult to express to those who have not seen it, because we have nothing in comparison to form our ideas upon: it is clear to perfection, a total quietude subsists, scarcely a cloud to be seen, and the light of the heavens, by the numerous appearance of the stars, affords a prospect both of wonder and contemplation.

"This observatory at Benares is said to have been built by the order of the emperor Ackbar: for as this wise prince endeavoured to improve the arts, so he wished also to recover the sciences of Hindostan, and therefore directed that three such places should be erected; one at Delhi, another at Agra, and the third at Benares."

**Edinburgh OBSERVATORY.** See EDINBURGH.

**OBSDIANUS LAPIS**, in the natural history of the ancients, the name of a stone which they have also described under the name of the *Chian marble*. It is a very smooth and hard marble, extremely difficult to cut, but capable of a fine polish; and was used among the ancient Greeks for the purpose of making reflecting mirrors. The later writers have supposed

the name *obsidianus* to be derived from somebody called *Obsidius*, who was the inventor of this use of it; but it seems only a false spelling of the word *opidianus*, *απο της οψιδος*, from seeing the images of things in it.

**OBSDIONALIS**, an epithet applied by the Romans to a fort of crown. See the article CROWN.

**OBSTETRICS**, or the **OBSTETRIC ART**, the same with **MIDWIFERY**.

**OBSTRUCTION**, in medicine, such an obturation of the vessels as prevents the circulation of the fluids, whether of the found and vital, or of the morbid and peccant kind, through them.

**OBTURATOR**, in anatomy. See ANATOMY, *Table of the Muscles*.

**OBTUSE**, signifies blunt, dull, &c. in opposition to acute or sharp. Thus we say, obtuse angle; obtuse angled triangle, &c.

**OBY**, or **OB**, a river of the Russian empire in Asia, which rises in the desert of Ichinsk, and, running north, joins the Irtyz near Tobolsk; and, still keeping its name, continues its course north, and falls into a deep bay called *Obskaya*, in about 63 degrees of latitude. The exact course of this river was unknown, till the country was surveyed by the Russians; who have given us good maps of it and of all Siberia. The Oby forms the boundary between Europe and Asia, and its course is upwards of 2000 miles in length.

**OCCIDENT**, in geography, the westward quarter of the horizon; or that part of the horizon where the ecliptic, or the sun therein, descends into the lower hemisphere; in contradistinction to *orient*. Hence we use the word *occidental* for anything belonging to the west; as occidental bezoar, occidental pearl, &c.

**OCCIPITAL**, in anatomy, a term applied to the parts of the occiput, or back part of the skull.

**OCCULT**, something hidden, secret, or invisible. The occult sciences are magic, necromancy, cabbala, &c.

**OCCULT**, in geometry, is used for a line that is scarce perceptible, drawn with the point of the compasses or a leaden pencil. These lines are used in several operations, as the raising of plans, designs of building, pieces of perspective, &c. They are to be effaced when the work is finished.

**OCCULTATION**, in astronomy, the time a star or planet is hid from our sight, by the interposition of the body of the moon or some other planet.

**OCCUPANCY**, in law, is the taking possession of those things which before belonged to nobody. This *Blackf.* is the true ground and foundation of all **PROPERTY**, or *Comment.* of holding those things in severality, which by the law of nature, unequalled by that of society, were common to all mankind. But, when once it was agreed that every thing capable of ownership should have an owner, natural reason suggested, that he who could first declare his intention of appropriating any thing to his own use, and, in consequence of such his intention, actually took it into possession, should thereby gain the absolute property of it; according to that rule of the law of nations, recognized by the laws of Rome, *quod nullius est, id ratione naturali occupanti conceditur*.

Occupancy. This right of occupancy, so far as it concerns real property, hath been confined by the laws of England within a very narrow compass; and was extended only to a single instance; namely, where a man was tenant *pour autre vie*, or had an estate granted to himself only (without mentioning his heirs) for the life of another man, and died during the life of *cestuy que vie*, or him by whose life it was holden: in this case, he that could first enter on the land, might lawfully retain the possession so long as *cestuy que vie* lived, by right of occupancy.

This seems to have been recurring to first principles, and calling in the law of nature to ascertain the property of the land, when left without a legal owner. For it did not revert to the grantor; who had parted with all his interest, so long as *cestuy que vie* lived: it did not escheat to the lord of the fee; for all escheats must be of the absolute entire fee, and not of any particular estate carved out of it; much less of so minute a remnant as this: it did not belong to the grantee; for he was dead: it did not descend to his heirs; for there were no words of inheritance in the grant: nor could it vest in his executors; for no executors could succeed to a freehold. Belonging therefore to nobody, like the *hereditas jacens* of the Romans, the law left it open to be seized and appropriated by the first person that could enter upon it, during the life of *cestuy que vie*, under the name of an occupant. But there was no right of occupancy allowed, where the king had the reversion of the lands: for the reversioner hath an equal right with any other man to enter upon the vacant possession; and where the king's title and a subject's interfere, the king's shall always be preferred. Against the king therefore there could be no prior occupant, because *nullum tempus occurrit regi*. And, even in the case of a subject, had the estate *pour autre vie* been granted to a man and his heirs during the life of *cestuy qui vie*, there the heir might, and still may, enter and hold possession, and is called in law a *special occupant*; as having a special exclusive right, by the terms of the original grant, to enter upon and occupy this *hereditas jacens*, during the residue of the estate granted: though some have thought him fo called with no very great propriety; and that such estate is rather a defendible freehold. But the title of *common occupancy* is now reduced almost to nothing by two statutes; the one, 29 Car. II. c. 3. which enacts, that where there is no special occupant, in whom the estate may vest, the tenant *pour autre vie* may devise it by will, or it shall go to the executors and be assets in their hands for payment of debts: the other that of 14 Geo. II. c. 20. which enacts, that it shall vest not only in the executors, but, in case the tenant dies intestate, in the administrators also; and go in course of a distribution like a chattel interest.

By these two statutes the title of *common occupancy* is utterly extinct and abolished: tho' that of *special occupancy*, by the heir at law, continues to this day; such heir being held to succeed to the ancestor's estate, not by descent, for then he must take an estate of inheritance, but as an occupant, specially marked out and appointed by the original grant. The doctrine of common occupancy may, however, be usefully remembered on the following account, amongst others: That, as by the common law no occupancy could be of incorporeal he-

reditaments, as of rents, tithes, advowsons, commons, Occupancy, or the like, (because, with respect to them, there could be no actual entry made, or corporal seisin had; and therefore by the death of the grantee *pour autre vie* a grant of such hereditaments was entirely determined): so now, it is apprehended, notwithstanding those statutes, such grant would be determined likewise; and the hereditaments could not be deviseable, nor vest in the executors, nor go in a course of distribution. For the statutes must not be construed so as to create any new estate, or to keep that alive which by the common law was determined, and thereby to defeat the grantor's reversion; but merely to dispose of an interest in being, to which by law there was no owner, and which therefore was left open to the first occupant. When there is a residue left, the statutes give it to the executors, &c. instead of the first occupant; but they will not create a residue, on purpose to give it to the executors. They only mean to provide an appointed instead of a casual, a certain instead of an uncertain, owner, of lands which before were nobody's; and thereby to supply this *casus omnisus*, and render the disposition of the law in all respects entirely uniform: this being the only instance wherein a title to a real estate could ever be acquired by occupancy.

For there can be no other case devised, wherein there is not some owner of the land appointed by the law. In the case of a sole corporation, as a parson of a church, when he dies or resigns, though there be no actual owner of the land till a successor be appointed, yet there is a *legal, potential* ownership, subsisting in contemplation of law; and when the successor is appointed, his appointment shall have a retrospect and relation backwards, so as to entitle him to all the profits from the instant that the vacancy commenced. And, in all other instances, when the tenant dies intestate, and no other owner of the lands is to be found in the common course of descents, there the law vests an ownership in the king, or in the subordinate lord of the fee, by escheat.

So also, in some cases, where the laws of other nations give a right by occupancy, as in lands newly created, by the rising of an island in a river, or by the alluvion or dereliction of the sea; in these instances, the law of England assigns them an immediate owner. For Bracton tells us, that if an island arise in the middle of a river, it belongs in common to those who have lands on each side thereof; but if it be nearer to one bank than the other, it belongs only to him who is proprietor of the nearest shore: which is agreeable to, and probably copied from, the civil law. Yet this seems only to be reasonable, where the soil of the river is equally divided between the owners of the opposite shores: for if the whole soil is the freehold of any one man, as it must be whenever a several fishery is claimed, there it seems just (and so is the usual practice) that the islets, or little islands, arising in any part of the river, shall be the property of him who owneth the piscary and the soil. However, in case a new island rise in the sea, though the civil law gives it to the first occupant, yet our's gives it to the king. And as to lands gained from the sea; either by *alluvion*, by the washing up of sand and earth, so as in time to make *terra firma*; or by *dereliction*, as when the sea shrinks back below the usual water-mark; in these

Occupant  
I  
Oceanus.

these cases the law is held to be, that if this gain be by little and little, by small and imperceptible degrees, it shall go to the owner of the land adjoining. For *de minimis non curat lex*: and, besides, these owners being often losers by the breaking in of the sea, or at charges to keep it out, this possible gain is therefore a reciprocal consideration for such possible charge or loss. But if the alluvion or dereliction be sudden and considerable, in this case it belongs to the king: for, as the king is lord of the sea, and so owner of the soil while it is covered with water, it is but reasonable he should have the soil when the water has left it dry. So that the quantity of ground gained, and the time during which it is gained, are what make it either the king's or the subject's property. In the same manner, if a river, running between two lordships, by degrees gains upon the one, and thereby leaves the other dry; the owner who loses his ground thus imperceptibly has no remedy: but if the course of the river be changed by a sudden and violent flood, or other hasty means, and thereby a man loses his ground, he shall have what the river has left in any other place, as a recompense for this sudden loss. And this law of alluvions and derelictions, with regard to rivers, is nearly the same in the imperial law; from whence indeed those our determinations seem to have been drawn and adopted: but we ourselves, as islanders, have applied them to *marine* increases; and have given our sovereign the prerogative he enjoys, as well upon the particular reasons before-mentioned, as upon this other general ground of prerogative, which was formerly remarked, that whatever hath no other owner is vested by law in the king. See PREROGATIVE.

OCCUPANT, in law, the person that first seizes or gets possession of a thing.

OCCUPATION, in a legal sense, is taken for use or tenure; as in deeds it is frequently said, that such lands are, or were lately, in the tenure of occupation of such a person.—It is likewise used for a trade or mystery.

OCCUPIERS of WALLING, a term used in the law-works for the persons who are the sworn officers that allot in particular places what quantity of salt is to be made, that the markets may not be overstocked, and see that all is carried fairly and equally between the lord and the tenant.

OCEAN, in geography, that vast collection of salt and navigable waters, in which the two continents, the first including Europe, Asia, and Africa, and the last America, are inclosed like islands.

The ocean is distinguished into three grand divisions. 1. The Atlantic ocean, which divides Europe and Africa from America, which is generally about 3000 miles wide. 2. The Pacific ocean, or South-sea, which divides America from Asia, and is generally about 10,000 miles over. And, 3. The Indian ocean, which separates the East Indies from Africa; which is 3000 miles over. The other seas, which are called *oceans*, are only parts or branches of these, and usually receive their names from the countries they border upon.

For the saltness, tides, &c. of the ocean, see the articles SEA, TIDES, &c.

OCEANUS, in Pagan mythology, the son of Cælus and Terra, the husband of Thetis, and the father

of the Rivers and Fountains. The ancients called him the *Father of all things*, imagining that he was produced by Humidity, which, according to Thales, was the first principle from which every thing was produced. Homer represents Juno visiting him at the remotest limits of the earth, and acknowledging him and Thetis as the parents of the gods. He was represented with a bull's head, as an emblem of the rage and bellowing of the ocean when agitated by a storm.

OCELLUS the LUCANIAN, an ancient Greek philosopher of the school of Pythagoras, who lived before Plato. His work *reperiatur in Maribus*, or "the Universe," is the only piece of his which is come down entire to us; and was written originally in the Dorci dialect, but was translated by another hand into the Attic. William Christian, and after him Lewis Nogarola, translated this work into Latin; and we have several editions of it, both in Greek and Latin.

OCHLOCRACY, that form of government wherein the populace have the chief administration of affairs.

OCHRE, in natural history, a genus of earths, slightly coherent, and composed of fine, smooth, soft, argillaceous particles, rough to the touch, and readily diffusible in water. Ochres are of various colours, as red, blue, yellow, brown, green, &c.

OCKLEY (Simon), a learned orientalist, was born at Exeter, in 1678, and educated at Queen's college, Cambridge, where he distinguished himself by his intense application to literature. At the usual time he took the degrees in arts, and that of bachelor in divinity; but marrying very young, was precluded from a fellowship in his college, and this occasioned his being afterwards involved in many difficulties. In 1705, he was presented to the vicarage of Swaveley in Cambridgeshire; and in 1711, he was chosen Arabic professor of the university; but afterwards had the misfortune to be confined for some time in Cambridge-castle for debt. The above preferments, however, he enjoyed till his death, which happened on the 9th of August 1720. He wrote, 1. *Introductio ad Linguas Orientales*. 2. The history of the present Jews throughout the world; translated from the Italian of Leo Modena, a Venetian rabbi. 3. The improvement of human reason, exhibited in the life of Hai Ebn Yokhdan, translated from the Arabic. 4. An account of South-west Barbary, containing what is most remarkable in the kingdoms of Fez and Morocco; written by a person who had been a slave there a considerable time, and translated from his manuscript. 5. The history of the Saracens, collected from the most authentic Arabic authors, in 2 vols 8vo. He was not only well skilled in the learned languages; but also in the modern, as French, Spanish, Italian, &c.

OCTAETARIDES, in chronology, denotes a cycle of eight years, at the end of which three entire lunar months were added. This cycle was used at Athens till Meton discovered the golden number.

OCTAGON, or OCTOGON, in geometry, is a figure of eight sides and angles; and this, when all the sides and angles are equal, is called a *regular octagon*, or one that may be inscribed in a circle.

OCTAGON, in fortification, denotes a place that has eight bastions. See FORTIFICATION.

OCTAHEDRON, or OCTAEDRON, in geometry,

Ocellus  
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Octahedron

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Ocandria one of the five regular bodies, consisting of eight equal and equilateral triangles.

Oczakow.

**OCTANDRIA** (*οκτα*, "eight," and *ανδρ*, a "man, or husband,") the eighth class in Linnæus's sexual system; consisting of plants with hermaphrodite flowers, which are furnished with eight stamens, or male organs of generation. See **BOTANY**, p. 1292.

**OCTANT**, or **OCTILE**, in astronomy, that aspect of two planets, wherein they are distant an eighth part of a circle, or 45°, from each other.

**OCTAPLA**, in matters of sacred literature, denotes a polyglot bible, consisting of eight columns, and as many different versions of the sacred text; viz. the original Hebrew both in Hebrew and Greek characters, Greek versions, &c.

**OCTATEUCH**, an appellation given to the eight first books of the Old Testament.

**OCTAVE**, in music. See **INTERVAL**.

**OCTOBER**, in chronology, the tenth month of the Julian year, consisting of 31 days; it obtained the name of *October*, from its being the eighth month in the calendar of Romulus.

**OCTOSTYLE**, in the ancient architecture, is the face of an edifice adorned with eight columns.

**OCULUS**, the **EYE**, in anatomy. See there, n° 406.

**OCULUS Belli**, in natural history, one of the semi-pellucid gems, of a greyish white colour, variegated with yellow, and with a black central nucleus: it is of a roundish form, and its variegations very beautifully represent the pupil and iris of the eye; whence the name.

**OCULUS Cati**. See **ASTERIA**.

**OCULUS Mundi**, one of the semi-pellucid gems, of a whitish-grey colour, without any variegations.

**OCYUM**, **BASIL**; a genus of the gynospermia order, belonging to the didynamia class of plants. There are eight species, all of them natives of warm climates, rising from six inches to two feet in height, and having a strong aromatic smell, resembling that of cloves. One of the species is used in the kitchen, particularly by the French cooks, who make great use of it in their soups and sauces. This rises about ten inches high, sending out branches by pairs opposite, from the bottom; the stalks and branches are four-cornered; the leaves are oval, spear-shaped, ending in acute points, and are indented on their edges; the whole plant is hairy, and has a strong scent of cloves too powerful for most persons, but to some it is very agreeable. These plants are propagated by seeds, and will thrive in this country in the open air, and will even ripen their seeds if placed in a stove or airy glass-case.

**OZKAKOW**, or **OZKAKOFF**, a town of Turkey in Europe, and capital of a Sangiac of the same name, inhabited by Tartars. During a late war, here was a Turkish garrison of 20,000 men. However, it was taken by the Russians in 1737, and all those that resisted were put to the sword. The Russians themselves lost 18,000 men in the assault. The Turks returned the same year with 70,000 men to retake it; but were obliged to retire, after the loss of 20,000. In 1738, the Russians withdrew their garrison, and demolished the fortifications. It is seated on the river Bog, to the west of the Nieper, or rather where they both unite

and fall into the Black Sea. It is 42 miles south-west of Bialagrod, and 190 north by east of Constantinople. E. Long. 30. o. N. Lat. 46. 30.

**ODA**, in the Turkish seraglio, signifies a class, order, or chamber. The grand signior's pages are divided into five classes or chambers. The first, which is the lowest in dignity, is called the *great oda*, from the great number of persons that compose it: these are the juniors, who are taught to read, write, and speak the languages. The second is called the *little oda*, where, from the age of 14 or 15 years, till about 20, they are trained up to arms, and the study of all the polite learning the Turks are acquainted with. The third chamber, called *kilar oda*, consists of 200 pages, which, besides their other exercises, are under the command of the *kilaridi-bachi*, and serve in the pantry and fruitery. The fourth consists only of 24, who are under the command of the *khazineci-bachi*, and have charge of the treasure in the grand signior's apartment, which they never enter with cloaths that have pockets. The fifth is called *kar-oda*, or *private chamber*; a .s is composed of only 40 pages who attend in the prince's chamber. Every night eight of these pages keep guard in the grand signior's bed-chamber, while he sleeps: they take care that the light, which is constantly kept in the room, does not glare in his eyes, lest it should awake him; and if they find him disturbed with troublesome dreams, they cause him to be awaked by one of their agas.

**ODA-Bachi**, or **Odobashi**, among the Turks, an officer equivalent to a serjeant or corporal among us.

**ODE**, in poetry, a song, or composition proper to be sung. See **POETRY**.

**ODENSEE**, a considerable town of Denmark, in the Isle of Funen, with a bishop's see. E. Long. 10. 27. N. Lat. 55. 28.

**ODER**, a river of Germany, which has its source near a town of the same name in Silesia, and on the confines of Moravia. It runs north through that province, and then into the Marche of Brandenburg and Pomerania, where it forms a large lake, afterwards falling into the Baltic Sea by three mouths; between which lie the islands Usedom and Wolin. It passes by several towns; as Ratibor, Oppelen, Breslau, Glogau, and Crossen, in Silesia; Francfort, Lebus, and Custrin, in Brandenburg; and Gartz, Stetin, Cammin, Wallin, Usedom, and Wolgait, in Pomerania.

**ODEUM**, in Grecian antiquity, a music-theatre, built by Pericles; the inside of which was filled with seats and ranges of pillars, and on the outside the roof descended shelving downwards from a point in the centre, with many bendings, in imitation of the king of Persia's pavilion. Here the musical prizes were contended for; and here also, according to Aristophanes, was a tribunal.

*De OdiO et Atia*. See **FALSE IMPRISONMENT**.

The writ *de odio et atia* was anciently used to be directed to the sheriff, commanding him to inquire whether a prisoner charged with murder was committed upon just cause of suspicion, or merely *propter odium et atiam*, for hatred and ill-will; and if upon the inquisition due cause of suspicion did not then appear, then there issued another writ for the sheriff to admit him to bail. This writ, according to Bracton, ought not to be denied to any man; it being expressly ordered

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to be made out *gratis*, without any denial, by *magna carta*, c. 26. and statute Westm. 2. 13 Edw. I. c. 29. But the statute of Gloucester, 6 Edw. I. c. 9. restrained it in the case of killing by misadventure or self-defence, and the statute 28 Edw. III. c. 9. abolished it in all cases whatsoever: but as the stat. 42 Ed. III. c. 1. repealed all statutes then in being, contrary to the great charter, Sir Edward Coke is of opinion that the writ *de odio et atia* was thereby revived. See *HABEAS Corpus*.

ODO (St.), second abbot of Clugni in France, was illustrious for learning and piety in the 10th century. The sanctity of his life contributed greatly to enlarge the congregation of Clugni; and he was so esteemed, that popes, bishops, and secular princes, usually chose him the arbiter of their disputes. He died about the year 942, and his works are printed in the Bibliothéque of Clugni.

ODO *Cantianus*, so called as being a native of Kent, in England, was a Benedictine monk in the 12th century, in which order his learning and eloquence raised him to the dignity of prior and abbot. Archbishop Becket was his friend, and his panegyric was made by John of Salisbury. He composed Commentaries on the Pentateuch, and the Second Book of Kings; Moral Reflections on the Psalms; treatises intitled, *De onere Philistin*; *De moribus Ecclesiasticis*; *De vitii et virtutibus Animæ*, &c.

ODONTALGIA, the TOOTHACH. See *MEDICINE*, n<sup>o</sup> 314. and p. 486g.

ODONTOIDE, in anatomy, an appellation given to the process of the second vertebra of the neck, from its resemblance to a tooth.

ODOROUS, or ODORIFEROUS, appellations given to whatever smells strongly, whether they be fetid or agreeable; but chiefly to things whose smell is brisk and agreeable.

ODYSSEY, a celebrated epic poem of Homer, wherein are related the adventures of Ulysses in his return from the siege of Troy.

OECONOMICS, the art of managing the affairs of a family, or community; and hence the person who takes care of the revenues and other affairs of churches, monasteries, and the like, is termed *oconomus*.

OECONOMY, denotes the prudent conduct, or discreet and frugal management, whether of a man's own estate, or that of another.

*Animal OECONOMY*, comprehends the various operations of nature in the generation, nutrition, and preservation of animals †. The doctrine of the animal economy is nearly connected with physiology, which explains the several parts of the human body, their structure, use, &c. See *ANATOMY* and *MEDICINE*.

OECUMENICAL, signifies the same with *general* or *universal*; as, oecumenical council, bishop, &c.

OEDEMA, or PHEGMATIC TUMOUR, in medicine and surgery, a sort of tumour attended with pale-ness and cold, yielding little resistance, retaining the print of the finger when pressed with it, and accompanied with little or no pain.

This tumour obtains no certain situation in any particular part of the body, since the head, eye-lids, hands, and sometimes part, sometimes the whole body, is affected with it. When the last mentioned is the case, the patient is said to be troubled with a cachexy, leu-

cophlegmatia, or dropfy. But if any particular part is more subject to this disorder than another, it is certainly the feet, which are at that time called *swelled* or *adematous feet*.

OEDIPUS, the unfortunate king of Thebes, whose history is partly fabulous, flourished about 1266 B. C. It is said he was given by his father to a shepherd, who was ordered to put him to death, in order to prevent the misfortunes with which he was threatened by an oracle. But the shepherd being unwilling to kill him with his own hands, tied him by the feet to a tree, that he might be devoured by wild beasts. The infant was, however, found in this situation by another shepherd named *Phorbas*, who carried him to Polybus king of Corinth; where the queen, having no children, educated him with as much care as if he had been her son. When he was grown up, he was informed that he was not the son of Polybus: on which, by order of the oracle, he went to seek for his father in Phocis; but scarce was he arrived in that country, when he met his father on the road, and killed him without knowing him. A short time after, having delivered the country from the monster called the *Sphinx*, he married Jocasta, without knowing that she was his mother, and had four children by her; but afterwards being informed of his incest, he quitted the throne, and, thinking himself unworthy of the light, put out his eyes. Eteocles and Polyneices, who were celebrated amongst the Greeks, were born of this incestuous marriage.

OELAND, an island of Sweden, seated on the Baltic sea, between the continent of Gothland and the isle of Gothland, in between 56° and 57° of north latitude, and between 17° and 18° of east longitude. It is about 60 miles in length, and 15 in breadth; having a wholesome air, and a fertile soil, with rising hills, and several castles. It has no town of any great note.

OENANTHE, WATER DROPPWORT; a genus of the digynia order, belonging to the pentandria class of plants. There are five species; of which the most remarkable is the crocata, or henlock dropwort, growing frequently on the banks of ditches, rivers, and lakes, in many parts of Britain. The roots and leaves of this plant are a terrible poison; several persons have perished by eating it through mistake, either for water-parsnips or for celery, which last it resembles pretty much in its leaves. So exceedingly deleterious is this plant, that Mr Lightfoot tells us, he has heard the late Mr Christopher d'Ehret, the celebrated botanic painter, say, that while he was drawing it, the smell or effluvia only rendered him so giddy, that he was several times obliged to quit the room, and walk out in the fresh air to recover himself; but recollecting at last what might be the probable cause of his repeated illness, he opened the door and windows of the room, and the free air then enabled him to finish his work without any more returns of the giddiness. Mr Lightfoot informs us, that he has given a spoonful of the juice of this plant to a dog, but without any other effect than that of making him very sick and stupid. In about an hour he recovered; and our author has seen a goat eat it with impunity. To such of the human species as have unfortunately eat any part of this plant, a vomit is the

molt

† See *Gene-ration, Nutrition, &c.*

Oenoptis most approved remedy.

**OENOPTÆ**, in Grecian antiquity, a kind of censors at Athens, who regulated entertainments, and took care that none drank too much, nor too little.

**OENOTHERA**, TREE-PRIMROSE; a genus of the monogynia order, belonging to the octandria class of plants. There are seven species; the most remarkable of which are,

1. The biennis, or common biennial tree-primrose. It hath a long, thick, deeply-furking root; crowned with many large, oval, spear-shaped, plane, spreading leaves; upright, thick, firm, rough, hairy stems, rising three or four feet high; garnished with long, narrow, lanceolate, close-fitting leaves, irregularly; and at all the axillas, from the middle upwards, large bright-yellow flowers.

2. Octovalvis, or octovalved, smooth, biennial tree-primrose, hath upright, firm, somewhat hairy stems, rising a yard high; and oblong, spear-shaped, pointed, plane, smooth leaves; and at the axillas large bright-yellow flowers.

3. The fruticoso, or shrubby, narrow-leaved, perennial tree-primrose, hath long thick roots; upright, under-shrubby like red stems, two or three feet high; spear-shaped, lightly-indented leaves; and at the axillas pedunculated clusters of yellow flowers, succeeded by pedicellated, acute-angled capsules.

4. The pumila, or low perennial tree-primrose, hath fibrous roots, crowned with many oval, spear-shaped, close-fitting leaves; slender herbaceous stems 10 or 12 inches long; garnished with spear-shaped, blunt, smooth leaves, having very short foot-stalks; and at the axillas smallest bright-yellow flowers, succeeded by acute-angled capsules.

All these plants flower very profusely in June and July, coming out almost half the length of the stalks from the axillas; and as the stalk advances in stature, new flowers are produced, succeeding those below; in which order the plants continue flowering from about midsummer till October: each flower is moderately large and conspicuous, consisting of four plane petals, which with the calix forms a very long tube below, and spreading above, generally expand most towards the evening; and are succeeded by plenty of seed in autumn for propagation.

These plants are exotics from America; but are all very hardy, prosper in any common soil and situation, and have been long in the English gardens, especially the three first sorts; but the *œnothera* biennis is the most commonly known.

The first and second species are biennial, and the third and fourth are perennial in root.

They are proper to be employed as plants of ornament for embellishing the pleasure-garden; they may be placed any-where, and will effect a very agreeable variety three or four months with their plentiful flow of flowers.

The biennial kinds must be raised annually from seed, for they totally perish after they have flowered. But the perennials, once raised, continue for years by the root.

The propagation of all the sorts is by seed, and the perennials also by parting the roots.

**OENOTRIA**, an ancient name of Italy; so called

from the *Oenotri*, (Virgil); inhabiting between *Pæstum* and *Tarentum*, (Ovid). Originally *Arcadians*, (*Dionysius Halicarnassicus*), who came under the conduct of *Oenotrus* son of *Lycæon*, 17 generations before the war of *Troy*, or 459 years, at 27 years each generation, and gave name to the people. *Cato* derives the name from *Oenotrus*, king of the *Sabines* and *Etruscans*; but *Varro* from *Oenotrus*, king of the *Latins*; and *Servius* from the Greek name for wine, for which Italy was famous; of which opinion is *Strabo*.

**OENOTRIDES** (*Strabo*, *Pliny*), two small islands in the *Tuscan* sea, over-against *Velia*, a town of *Lucania*, called *Pontia* and *Ischia*; now *Penza* and *Ischia*, on the coast of the *Principato Citra*, or to the west of *Naples*. So called from the *Oenotri*, an ancient people of Italy.

**OESSEL**, an island of the *Baltic* sea, at the entrance of the gulf of *Livonia*. It is about 70 miles in length, and 50 in breadth, and contains 10 parishes. It is defended by the fortresses of *Airenburg* and *Sonneburg*. It is in between 22° and 24° of east longitude, and between 58° and 59° of north latitude.

**OESOPHAGUS**, in anatomy, the *GULA*, or *Gullet*, is a membranaceous canal, reaching from the fauces to the stomach, and conveying into it the food taken in at the mouth. See *ANATOMY*, n° 353.

**OESTRUS**, in zoology, a genus of insects belonging to the order of diptera. It has no mouth; but three punctures, without trunk or beak: Antennæ taper, proceeding from a lenticular joint. There are five species.

1. *Bovis*, the breeze or gad-fly. Thorax yellow, with a black transverse line between the wings: Abdomen tawny, with fine black transverse lines; last segment black: Wings white, with a brown transverse line, and three brown spots. Size of the large blue fly. Deposits its eggs under the skin on the backs of oxen, where the maggots are nourished the whole winter till the month of June; and plague the cattle so all the summer, that they are obliged to fly for refuge into the water, and dare not quit it the whole day.

2. The hæmorrhoidalis. Body long, black, covered with tawny hair; middle of the thorax less hairy; wings immaculate; antennæ very short: Length half an inch. Deposits its eggs in the rectum of horses, and occasions great torment.

3. *Ovis*, the grey-fly. Spotted with black; front pale yellow; legs brownish; wings with short black veins: Length half an inch. Breeds in the frontal sinus of sheep; where the maggots, hatched from the eggs, lodge the whole winter, vellicating the internal membranes, and often bringing on death.

5. The *nafalis*. Body black; but the head, thorax, and abdomen, covered with pale-red hair, except the first segment of the latter, which is covered with white hair; the wings immaculate. Breeds in the fauces of horses, entering by their nose.

5. The *tarandi*. Thorax yellow; with a black line between the wings, which are immaculate: abdomen tawny, last segment black. Insect the back of the rein-deer, so as greatly to retard the breed. The rein-deer of *Lappland* are obliged every year to fly to the

Oenotrides  
Oestrus.

the Alpine mountains, to escape the pursuit of these insects: yet a fourth part of their number perish by them at two years old; the rest are emaciated, and have their skins spoiled.

**OETA** (Strabo, Ptolemy), a mountain of Thessaly, extending from Thermopylæ westward to the Sinus Ambracius, and in some measure cutting at right angles the mountainous country stretching out between Parnassus to the south, and Pindus to the north. At Thermopylæ it is very rough and high, rising and ending in sharp and steep rocks, affording a narrow passage between it and the sea from Thessaly to Locris, (Strabo): with two paths over it; the one above Trachis, very steep and high; the other through the country of the Ænians, much easier and readier for travellers; by this it was that Leonidas was attacked in rear by the Persians, (Pausanias). Here Hercules laid himself on the funeral pile, (Silius Italicus, Ovid); the spot thence called *Pyra*, (Livy): who says, that the extreme mountains to the east are called *Oeta*; and hence the poets allege, that day, night, sun, and stars, arose from Oeta, (Seneca, Statius, Silius Italicus, Catullus, Virgil's *Culex*.) Circumstances which shew the height of this mountain.

**OETING**, a town of Germany, in Upper Bavaria, under the jurisdiction of Burkhauen. It is divided into the upper and the lower town, and seated on the river Inn, eight miles west of Burkhauen. E. Long. 12. 47. N. Lat. 48. 0. There is a great resort of pilgrims to the old chapel.

**OETING**, or *Oettingen*, a town of Germany, in the circle of Suabia, and capital of a county of the same name, seated on the river Wirnitz. E. Long. 10. 45. N. Lat. 48. 52.

**OETING**, a county of Germany, in the circle of Suabia, bounded on the north and east by Franconia; on the south by the duchy of Neuburg; and on the west by that of Wirtemberg. It is about 40 miles from east to west, and 20 from north to south.

**OFFA'S-DYKE**, an entrenchment cast up by Offa, a Saxon king, to defend England against the incursions of the Welch. It runs through Herefordshire, Shropshire, Montgomeryshire, Denbighshire, and Flintshire.

**OFFANTO**, a river of Italy, in the kingdom of Naples. It rises in the Appennine mountains, in the Farther Principato; and passing by Conza, and Monte Verde, it afterwards separates the Capitanata from the Basilicata and the Terra-di-Barri, and then it falls into the gulf of Venice, near Salpe.

**OFFENCE**, in law, an act committed against the law, or omitted where the law requires it.

**OFFICE**, a particular charge or trust, or a dignity attended with a public function. See **HONOUR**.—The word is primarily used in speaking of the offices of judicature and policy; as the office of secretary of state, the office of a sheriff, of a justice of peace, &c.

**OFFICE** also signifies a place or apartment appointed for officers to attend in, in order to discharge their respective duties and employments; as the secretary's office, ordnance-office, excise-office, signet-office, paper-office, pipe-office, six-clerks office, &c.

**OFFICE**, in architecture, denotes all the apartments appointed for the necessary occasions of a pa-

lace or great house; as kitchen, pantries, confectionaries, &c.

**OFFICE**, in the canon-law, is used for a benefice that has no jurisdiction annexed to it.

*Duty upon OFFICES and Pensions*, a branch of the king's extraordinary perpetual revenue, consisting in a payment of 1s. in the pound (over and above all other duties) out of all salaries, fees, and perquisites, of offices and pensions payable by the crown. This highly-popular taxation was imposed by stat. 3 Geo. II. c. 22. and is under the direction of the commissioners of the land-tax.

**OFFICER**, a person possessed of a post or office. See the preceding article.

The great officers of the crown, or state, are, The lord high-steward, the lord high-chancellor, the lord high-treasurer, the lord-president of the council, the lord privy-seal, the lord-chamberlain, the lord high-constable, and the earl-marshal; each of which fee under its proper article.

*Non-commissioned OFFICERS*, are serjeant-majors, quarter-master serjeants, serjeants, corporals, drum and fife majors; who are nominated by their respective captains, and appointed by the commanding officers of regiments, and by them reduced without a court-martial.

*Orderly non-commissioned OFFICERS*, are those who are orderly, or on duty for that week; who, on hearing the drum beat for orders, are to repair to the place appointed to receive them, and to take down in writing, in the orderly book, what is dictated by the adjutant, or serjeant-major: they are then immediately to shew these orders to the officers of the company, and afterwards warn the men for duty.

*Flag OFFICERS*. See **FLAG OFFICERS**, and **ADMIRALS**.

*General OFFICERS*, are those whose command is not limited to a single company, troop, or regiment; but extends to a body of forces composed of several regiments: such are the general, lieutenant-general, major-general, and brigadier.

*OFFICERS of the Household*. See the article **HOUSEHOLD**.

*Staff OFFICERS*, are such as, in the king's presence, bear a white staff, or wand; and at other times, on their going abroad, have it carried before them by a footman bare-headed: such are the lord-steward, lord-chamberlain, lord-treasurer, &c.

The white staff is taken for a commission; and, at the king's death, each of these officers breaks his staff over the hearth made for the king's body, and by this means lays down his commission, and discharges all his inferior officers.

*Subaltern OFFICERS* are all who administer justice in the name of subjects; as those who act under the earl-marshal, admiral, &c. In the army, the subaltern officers are the lieutenants, cornets, ensigns, serjeants, and corporals.

**OFFICIAL**, in the canon-law, an ecclesiastical judge, appointed by a bishop, chapter, abbot, &c. with charge of the spiritual jurisdiction of the diocese.

**OFFICIAL** is also a deputy appointed by an arch-deacon as his assistant, who sits as judge in the arch-deacon's

Official  
deacon's court.

Ogilby.

**OFFICINAL**, in pharmacy, an appellation given to such medicines, whether simple or compound, as are required to be constantly kept in the apothecaries shops. The *officials* are appointed, among us, by the college of physicians; and the manner of making the compositions directed in their dispensatory. See **PHARMACY**.

**OFFING**, or **OFFIN**, in the sea-language, that part of the sea a good distance from shore, where there is deep water, and no need of a pilot to conduct the ship: thus, if a ship from shore be seen sailing out to seaward, they say, *she stands for the offing*; and if a ship, having the shore near her, have another a good way without her, or towards the sea, they say, *that ship is in the offing*.

**OFF-SETS**, in gardening, are the young shoots that spring from the roots of plants; which being carefully separated, and planted in a proper soil, serve to propagate the species.

**OFF-SETS**, in surveying, are perpendiculars let fall, and measuring from the itinary lines to the hedge, fence, or extremity of an inclosure.

**OGEE**, or **O. G.** in architecture, a moulding consisting of two members, the one concave, and the other convex; or of a round and hollow, like an S. See **ARCHITECTURE**.

**OGILBY** (John), an eminent writer, was born in or near Edinburgh, about the 17th of November 1600. His father having spent his estate, and being prisoner in the King's Bench for debt, could contribute but little to his education; however, he obtained some knowledge in the Latin grammar, and afterwards so much money as to procure his father's discharge from prison, and to bind himself an apprentice to a dancing-master in London; when, by his dexterity in his profession, and his compliant behaviour to his master's scholars, he obtained money to buy out the remainder of his time, and to set up for himself. But being afterwards appointed to dance in the duke of Buckingham's great mask, he by a false step strained a vein in the inside of his leg, which occasioned his being ever after somewhat lame. When Thomas earl of Strafford was made lord lieutenant of Ireland, he was entertained as a dancing-master in his family, and made one of the earl's troop of guards; at which time he composed a humorous piece called the *Character of a Trooper*. He was soon after appointed master of the revels in Ireland, and built a theatre at Dublin. About the time of the conclusion of the war in England, he left Ireland, and, being shipwrecked, came to London in a necessitous condition; but soon after walked to Cambridge, where, being assisted by several scholars, he became to complete a master of the Latin tongue, that in 1649 he published a translation of Virgil. He soon after learned Greek; and in 1660 published in folio, a translation of Homer's *Iliad*, with Annotations. About two years after, he went into Ireland, where he was made master of the revels by patent. He then built another theatre in Dublin, which cost him about 1000 l. He published at London in folio, a translation of Homer's *Odyssey*, with Annotations; and afterwards wrote two heroic poems, intitled the *Ephebian Matron*, and the *Roman Slave*. He next composed the *Carolics*, an epic poem, in 12 books, in honour of

king Charles I. but this was entirely lost in the fire of London; when Mr Ogilby's house in White Fryars was burnt down, and his whole fortune, except to the value of five pounds, destroyed. He, however, soon procured his house to be re-built, set up a printing-office within it, was appointed his majesty's cosmographer and geographic printer, and printed several great works, translated or collected by himself and his assistants, particularly his *Atlas*. He died in 1676.

**OGIVE**, in architecture, an arch or branch of a Gothic vault; which, instead of being circular, passes diagonally from one angle to another, and forms a cross with the other arches. The middle, where the ogives cross each other, is called the *key*; being cut in form of a rose, or a *cul de lampe*. The members or mouldings of the ogives are called *nerves*, *branches*, or *reins*; and the arches which separate the ogives, *double arches*.

**OGYGES**, king of the Thebans, or, as others, of Ogygia and Acte, afterwards called *Bœotia* and *Attica*. He is recorded to have been the first founder of Thebes and Eleasin. The famous deluge happened in his time, in which some say he perished with all his subjects, 1796 B. C.

**OGYIA**, (Homer), the island of Calypso; placed by Pliny in the Sinus Sæyæacæ, in the Ionian sea, opposite to the promontory Lacinium; by Mela in the strait of Sicily, calling it *Ææ*; which others place at the promontory Circeium, and call it the island of *Circe*.

**OGYIA**, the ancient name of Thebes in Bœotia; so called from Ogyges, an ancient king, under whom happened a great deluge, 1020 years before the first olympiad.

**OHIO**, a river of North America, called by the French the *Beautiful River*, has its source between the Allegany mountains and the lake Erie; and running south-west through a most delightful country, as also receiving many smaller rivers in its passage, at length falls into the Mississippi, in about 37 degrees of latitude. The French had several forts on and near it; but the whole country through which it flows was ceded by the peace of 1763 to the British.

**O HETEROA**, one of the South Sea islands lately discovered, is situated in W. Long. 150. 47. S. Lat. 22. 27. It is neither fertile nor populous; nor has it an harbour or anchorage fit for shipping, and the disposition of the people is hostile to such as visit them.

**OIL**, in natural history, an unctuous inflammable substance, drawn from several natural bodies, as animal and vegetable substances.

Animal oils are their fats, which are originally vegetable oils: all animal substances yield them, together with their volatile salts, in distillation.

Vegetable oils are obtained by expression, infusion, and distillation.

The oils by expression are obtained from the seed, leaves; fruit, and bark of plants; thus, the seed of mustard, and of the sun-flower, almonds, nuts, beech-mast, &c. afford a copious oil by expression; and the leaves of rosemary, mint, rue, wormwood, thyme, sage, &c. the berries of juniper, olives, Indian cloves, nutmeg, mace, &c. the barks of cinnamon, cassiafras, and clove, yield a considerable proportion of essential oil by distillation.

The



The method of procuring oils by expression is very simple: thus, if either sweet or bitter almonds, that are fresh, be pounded in a mortar, the oil may be forced out with a press, not heated: and in the same manner should the oil be pressed from linseed and mustard. The avoiding the use of heat in preparing these oils, intended for internal medicinal use, is of great importance, as heat gives them a very prejudicial rancidness.

This method holds of all those vegetable matters that contain a copious oil, in a loose manner, or in certain cavities or receptacles; the sides whereof being broke, or squeezed, makes them let go the oil they contain: and thus the zeit or oil of lemon-peel, orange-peel, citron-peel, &c. may be readily obtained by pressure, without the use of fire. But how far this method of obtaining oils may be applied to advantage, seems not hitherto considered. It has been commonly applied to olives, almonds, linseed, rape-seed, beech-mast, ben-nuts, walnuts, bay-berries, mace, nutmeg, &c. but not, that we know of, to juniper-berries, cashew-nuts, Indian cloves, pine apples, and many other substances that might be enumerated, both of foreign and domestic growth. It has, however, been of late successfully applied to mustard-seed, so as to extract a curious gold-coloured oil, leaving a cake behind, fit for making the common table-mustard.

Certain dry matters, as well as moist ones, may be made to afford oils by expression, by grinding them into a meal, which being suspended to receive the vapour of boiling water, will thus be moistened so as to afford an oil in the same manner as almonds; and thus an oil may be procured from linseed, hemp-seed, lettuce-seed, white-poppy seed, &c.

As to the treatment of oils obtained by expression, they should be suffered to deurate themselves by standing in a moderately cool place, to separate from their water, and deposit their feces; from both which they ought to be carefully freed. And if they are not thus rendered sufficiently pure, they may be washed well with fresh water, then thoroughly separated from it again by the separating-glass, whereby they will be rendered bright and clear.

The next class of oils are those made by infusion, or decoction, wherein the virtues of some herb or flower is drawn out in the oil; as the oils of roses, chamæmile, hypericum, elder, &c. However, these require to be differently treated: thus, for the scented flowers, particularly roses, insolation does best; because much boiling would exhale their more fragrant parts: but oils impregnated with green herbs, as those of chamæmile and alder, require long boiling, before they receive the green colour desired. And, in general, no oils will bear to be boiled any longer than there remains some aqueous humidity, without turning black.

There are many compound oils prepared in the same manner, *viz.* by boiling and insolation, and then straining off the oil for use.

The same contrivance has likewise its use in making essences for the service of the perfumer; not only where essential oils cannot be well obtained in sufficient quantities, but also where they are too dear. The essential oil of jessamine-flowers, honey-fuckles, sweet-briar, damask-roses, lilies of the valley, &c. are either extremely dear, or scarcely obtainable by distillation;

and, in some of them, the odorous matter is so subtle, as almost to be lost in the operation. But if these flowers be barely infused in fine oil of nuts, or oil of ben, drawn without heat, and kept in a cool place, their subtle odorous matter will thus pass into the oil, and richly impregnate it with their flavour. And these essences may be rendered still more perfect by straining off the oil at first put on, and letting it stand again, without heat, upon fresh flowers; repeating the operation twice or thrice.

Oils or fats may likewise be obtained, by boiling and expression, from certain animal-substances; for the membranes which contain the fat, being chopped small, and set in a pan over the fire, become fit for the canvas bag, and, by pressure, afford a large quantity of fat; as we see in the art of chandlery, which thus extracting the oily matter, leaves a cake behind, commonly called *grave*.

As to the essential oils of vegetables, they are obtained by distillation with an alembic and a large refrigeratory. Water must be added to the materials, in sufficient quantity to prevent their burning; and they should be macerated or digested in that water, a little time before distillation. The oil comes over with the water; and either swims on the top, or sinks to the bottom, according as it is specifically heavier or lighter than water.

This process is applicable to the distilling of the essential oils from flowers, leaves, barks, roots, woods, gums, and balsams, with a slight alteration of circumstances, as by longer digestion, brisker distillation, &c. according to the tenacity and hardness of the subject, the ponderosity of the oil, &c.

Essential oils may be divided into two classes, according to their different specific gravities; some floating upon water, and others readily sinking to the bottom. Thus, the essential oils of cloves, cinnamon, and saffras, readily sink; whereas those of lavender, marjoram, mint, &c. swim in water: the lightest of these essential oils is, perhaps, that of citron-peel, which even floats in spirit of wine; and the heaviest seems to be oil of saffras.

For obtaining the full quantity of the more ponderous oils from cinnamon, cloves, saffras, &c. it is proper to reduce the subjects to powder; to digest this powder for some days in a warm place, with thrice its quantity of soft river-water, made very saline by the addition of sea-salt, or sharp with oil of vitriol; to use the strained decoction, or liquor left behind in the still, instead of common water, for fresh digestion; to use for the same purpose the water of the second running, after being cleared of its oil; not to distil too large a quantity of these subjects at once; to leave a considerable part of the still, or about one fourth, empty; to use a brisk fire, or a strong boiling heat, at the first, but to slacken it afterwards; to have a low still-head, with a proper internal ledge and current leading to the nose of the worm; and, finally, to cohobate the water, or pour back the liquor of the second running upon the matter in the still, repeating this once or twice.

The directions here laid down for obtaining the ponderous oils to advantage, are easily transferred to the obtaining of the lighter; so that we need not dwell particularly upon them.

Many of the essential oils being dear, it is a very common practice to adulterate or debase them several ways, so as to render them cheaper both to the seller and the buyer. These several ways seem reducible to three general kinds, each of which has its proper method of detection, viz. 1. With expressed oils. 2. With alcohol. And, 3. With cheaper essential oils.

If an essential oil be adulterated with an expressed oil, it is easy to discover the fraud; by adding a little spirit of wine to a few drops of the suspected essential oil, and shaking them together; for the spirit will dissolve all the oil that is essential, or procured by distillation, and leave all the expressed oil that was mixed with it, untouched.

If an essential oil be adulterated with alcohol, or rectified spirit of wine, it may be done in any proportion, up to that of an equal quantity, without being easily discoverable either by the smell or taste: the way to discover this fraud, is to drop a few drops of the oil into a glass of fair water; and if the oil be adulterated with spirit, the water will immediately turn milky, and, by continuing to shake the glass, the whole quantity of spirit will be absorbed by the water, and leave the oil pure at top.

Finally, if an essential oil be adulterated by a cheaper essential oil, this is commonly done very artfully: the method is to put fir-wood, turpentine, or oil of turpentine, into the still, along with the herbs to be distilled for their oil, such as rosemary, lavender, origanum, &c. and by this means, the oil of turpentine distilled from these ingredients, comes over in great quantity, and intimately blended with the oil of the genuine ingredient. The oils thus adulterated always discover themselves in time, by their own flavour being overpowered by the turpentine-smell: but the ready way to detect the fraud, is to drench a piece of rag, or paper, in the oil, and hold it before the fire; for thus the grateful flavour of the plant will fly off, and leave the naked turpentine-scent behind.

The virtues of oils being the same with those of the substances from whence they are obtained, may be learned under their several articles.

*Method of Purifying Rancid Oils.* See CHEMISTRY, n<sup>o</sup> 497.

ONTIMENT, in pharmacy. See UNGUENT.

OKEHAM, the capital of Rutlandshire, in England, seated in a rich and pleasant valley, called the *vale of Catmus*. It is pretty well built, has a good church, a free-school, and an hospital. W. Long. o. 45. N. Lat. 52. 40.

OKINGHAM, OCKINGHAM, or *Woxingham*, a large town of Berkshire, in England, noted for the manufacture of silk stockings. W. Long. o. 50. N. Lat. 51. 26.

OLAUS MAGNUS, archbishop of Upsal in Sweden, succeeded his brother John Magnus in 1544. He appeared with great credit at the council of Trent in 1546, and suffered much afterward for the Catholic religion. We have of his writing, *A History of the Manners, Customs, and Wars of the Northern Nations of Europe*.

OLD-AGE. See LONGEVITY.

OLD-*Man of the Mountain*. See ASSASSINS.

OLDCASTLE (Sir John), called the *Good Lord*

*Cobham*, was born in the reign of Edward III. and was the first author as well as the first martyr among the English nobility: he obtained his peerage by marrying the heiress of that Lord Cobham who with so much virtue and patriotism opposed the tyranny of Richard II. By his means the famous statute against provisors was revived, and guarded against by severer penalties; he was one of the leaders of the reforming party; was at great expence in procuring and dispersing copies of Wickliffe's writings among the people, as well as by maintaining a number of his disciples as itinerant preachers. In the reign of Henry V. he was accused of heresy; the growth of which was attributed to his influence. Being a domestic in the king's court, the king delayed his prosecution that he might reason with him himself; but not being able to reclaim him to the church of Rome, he in great displeasure resigned him to its censure. He was apprehended and condemned for heresy; but escaping from the tower, lay concealed for four years in Wales, until the rumour of a pretended conspiracy was raised against him, and a price set upon his head: he was at last seized, and executed in St Giles's Fields; being hung alive in chains upon a gallows, and burned by a fire placed underneath. He wrote "Twelve Conclusions, addressed to the Parliament of England."

OLDENBURG (Henry), a learned German gentleman in the 17th century, was descended from the noble family of his name, who were earls of the county of Oldenburg, in the north part of Westphalia for many generations. He was born in the duchy of Bremen in the Lower Saxony; and during the long English parliament in king Charles I's time, was appointed consul for his countrymen, at London, after the usurpation of Cromwell: but being discharged of that employ, he was made tutor to the lord Henry O'Bryan, an Irish nobleman, whom he attended to the university of Oxford, where he was admitted to study in the Bodleian library in the beginning of the year 1656, when Cromwell was vice-chancellor. He was afterwards tutor to William lord Cavendish, and was acquainted with Milton the poet. During his residence at Oxford, he became also acquainted with the members of that society there, which gave birth to the royal society; and upon the foundation of this latter, he was elected fellow; and when the society found it necessary to have two secretaries, he was chosen assistant-secretary to Dr Wilkins. He applied himself with extraordinary diligence to the business of his office, and began the publication of the Philosophical Transactions with N<sup>o</sup> 1. in 1664. In order to discharge this talk with greater credit to himself and the society, he held a correspondence with more than seventy learned persons, and others, upon a vast variety of subjects, in different parts of the world. This fatigue would have been insupportable, had not he, as he told Dr Lister, managed it so as to make one letter answer another, and that, to be always fresh, he never read a letter before he had pen, ink and paper, ready to answer it forthwith; so that the multitude of his letters cloyed him not, nor ever lay upon his hands. Among others, he was a constant correspondent of Mr Robert Boyle, with whom he had a very intimate friendship; and he translated several of that ingenious gentleman's works into Latin.

Mr Oldenburg continued to publish the Transactions, as before, to N<sup>o</sup>. xxxvi. June 25, 1677. After which the publication was discontinued till the January following, when it was again resumed by his successor in the secretary's office, Mr Nehemiah Crew, who carried it on till the end of February 1678. Our author dying at his house at Charlton, near Greenwich in Kent, in the month of August that year, was interred there.

OLDHAM (John), an eminent English poet in the 17th century, son of a non-conformist minister, was educated under his father, and then sent to Edmund-hall in Oxford. He became usher to the free-school at Croyden in Surry; where he received a visit from the earls of Rochester and Dorset, Sir Charles Sedley, and other persons of distinction, merely upon the reputation of some verses which they had seen in manuscript. He was tutor to several gentlemen's sons successively; and having saved a small sum of money, came to London, and became a perfect votary to the bottle, being an agreeable companion. He was quickly found out here by the noblemen who had visited him at Croyden, who brought him acquainted with Mr Dryden. He lived merrily with the earl of Kingston at Holme-Pierpoint in Nottinghamshire, where he died of the small-pox in 1683, in the 30th year of his age. His acquaintance with learned authors appears by his satires against the Jesuits, in which there is as much learning as wit discovered. Mr Dryden esteemed him highly. His works are printed in 2 vols 12mo. They chiefly consist of satires, odes, translations, paraphrases of Horace and other authors, elegiac verses, imitations, parodies, familiar epistles, &c.

OLDMIXON (John) was descended from an ancient family in Somersetshire: he was a violent party-writer and malevolent critic, who would scarcely have been remembered, if Pope, in resentment of his abuse, had not condemned him to immortality in his Dunciad. His party-writings procured him a place in the revenue at Liverpool, where he died at an advanced age in the year 1745. Besides his fugitive temporary pieces, he wrote a history of the Stuarts in folio; a critical history of England, 2 vols 8vo; a volume of poems, some dramatic pieces, &c.; none of them worthy of notice, his principal talent being that of falsifying history.

OLD WIFE, or *Wraffe*. See LABRUS.

OLD WIFE *Fish*. See BALISTES.

OLEA, the OLIVE-TREE; a genus of the monogynia order, belonging to the diandria class of plants.

There are two species, 1. The Europea, or common olive-tree, rises with upright solid stems, branching numerously on every side, 20 or 30 feet high; spear-shaped, stiff, opposite leaves, two or three inches long, and half an inch or more broad; and at the axillas small clusters of white flowers, succeeded by oval fruit.

This species is the principal sort cultivated for its fruit; the varieties of which are numerous, varying in size, colour, and quality.

It is a native of the southern warm parts of Europe, and is cultivated in great quantities in the south of France, Italy, and Portugal, for the fruit to make the olive-oil, which is in so great repute, and is trans-

ported to all parts. to the great advantage of those countries where the trees grow in the open ground: the green fruit is also in much esteem for pickling, of which we may see plenty in the shops.

2. The *capensis*, or cape box-leaved olive, rises with shrubby stems, branching numerously from the bottom, six or seven feet high; small, oval, thick, stiff, shining leaves; and at the axillas small clusters of whitish flowers; succeeded by small fruit of inferior value.

These plants in this country must be kept principally in pots for moving to shelter of a green-house in winter; for they are too tender to prosper well in the open ground here: though sometimes they are planted against a warm south wall, and sheltered occasionally from frost in winter, by mulching the roots, and matting their tops; whereby they may be preserved, and will sometimes produce fruit for pickling: a very severe winter, however, often kills or greatly injures their young branches; therefore let the principal part be potted in rich earth, and placed among the green-house shrubs, and managed as others of that kind.

These trees are often sent over from Italy to the Italian warehouses in London, along with orange-trees, &c. where pretty large plants may be purchased reasonably, which should be managed as directed for orange-trees that are imported from the same country. See CITRUS.

Their propagation here is commonly by layers.

The laying is performed on the young branches in spring. Give plenty of water all summer, and they will sometimes be rooted fit for potting-off by autumn; but sometimes they require two summers to be rooted effectually; when, however, they are properly rooted take them off early in autumn, and pot them separately, give water, and place them in the shade till they have taken fresh root; and in October remove them into the green-house, &c.

Those you intend to plant in the open ground, as before suggested, should be kept in pots; in order to have occasional shelter of a garden-frame two or three years, till they have acquired some size, and are hardened to the full air; then transplant them into a warm border against a wall; mulch their roots in winter, and mat their tops in frosty weather.

Olives have an acrid, bitter, extremely disagreeable taste: pickled (as we receive them from abroad) they prove less disagreeable. The *Lucaea* olives, which are smaller than the others, have the weakest taste; the Spanish, or larger, the strongest; the Provence, which are of a middling size, are generally the most esteemed.

The oil obtained from this fruit has no particular taste or smell, and does not greatly differ in quality from oil of almonds. Authors make mention of two sorts of this oil, one expressed from the olives when fully ripe, which is our common oil olive; the other, before it has grown ripe; this is called *oleum immaturum*, and *omphaeinum*. Nothing is met with in the shops under this name; and Lemery affirms, that there is no such oil, unripe olives yielding only a viscid juice to the press. From the ripe fruit, two or three sorts are obtained, differing in degree of purity: the purest runs by light pressure; the remaining magma, heated and pressed

Oleaginous || Oleron. fed more strongly, yields an inferior sort, with some dregs at the bottom, called *amureca*. All these oils contain a considerable quantity of aqueous moisture, and a mucilaginous substance, which subject them to run into a putrid state; to prevent this, the preparers add some sea-salt, which, imbibing the aqueous and mucilaginous parts, sinks with them to the bottom; by this means the oil becomes more homogeneous, and consequently less susceptible of alteration. In its passage to us, some of the salt, thrown up from the bottom by the flaking of the vessel, is sometimes mixed with and detained in the oil, which, in our colder climate, becomes too thick to suffer it freely to subside; and hence the oil is sometimes met with of a manifestly saline taste. Oil-olive is used in the simple balsam of sulphur, Locatelli's balsam, and several ointments. It is oftener employed in this last intention than the other expressed oils, but more rarely for internal medicinal purposes.

OLEAGINOUS, something that partakes of the nature of oil, or out of which oil may be expressed.

OLECRANUM, or OLECRANON, in anatomy, the protuberance of the ulna, which prevents the joint of the elbow from being bent back beyond a certain length. See ANATOMY, n<sup>o</sup> 50.

OLEARIUS (Adam), minister to the duke of Holstein, and secretary to the embassy sent in 1633 to the great duke of Muscovy and to the king of Persia. He spent six years in this employment; and, on his return, published a relation of his journeys, with maps and figures, at Sleswic 1656, in folio. He wrote an *Abridgement of the chronicles of Holstein from 1448 to 1663*; and was appointed librarian to the duke of Holstein, in which capacity he probably died. He has the character of an able mathematician, an adept of music, and a good orientalist, especially in the Persian language.

OLEARIUS (Godfrey), son of Godfrey Olearius, D. D. superintendent of Halle in Saxony, was born there in 1639. He became professor of Greek at Leipzig; and shewed his abilities in that language by 52 exercitations on the dominical epistles, and upon those parts of the epistles in the New Testament which are read in the public exercises, and which among the Lutherans are the subject of part of their sermons. He discharged the most important posts in the university, and among other dignities was ten times rector of it. His learning and industry were displayed in 106 theological disputations, 61 in philosophy, some programmas upon difficult points, several speeches and theological counsels; which make two thick volumes: besides his *Moral Theology*, his *Introduction to Theology*, which treats of cases of conscience, and his *Hermeneutica Sacra*. He lived to a good old age, dying in 1713. His eldest son of his own name, was a man of genius and learning, a professor in the same university, who published several works, but died young of a consumption before his father.

OLERON, an island of France, on the coast of Anis and Saintonge, about five miles from the continent. It is 12 miles in length, and five in breadth; and is very fertile, containing about 12,000 inhabitants, who are excellent seamen. It is defended by a castle, which is well fortified; and there is a light-house placed here for the direction of ships. It is 14

miles south-east of Rochelle. W. Long. 1. 26. N. Lat. 46. 10.

*Sea-Laws of OLERON*, certain laws relative to maritime affairs, made in the time of Richard I. when he was at the island of Oleron. These laws, being accounted the most excellent sea-laws in the world, are recorded in the black book of the admiralty. See *Selden's Mare Clausum*.

OLFACTORY-NERVES. See ANATOMY, n<sup>o</sup> 400.

OLIBANUM, (FRANKINCENSE), in pharmacy, a dry resinous substance, brought to us in detached pieces, or drops, as it were, like those of mastic; but larger, and of a less pure and pellicid texture. This drug has received many different appellations, according to its different appearances: the single tears are called simply *olibanum*, or *thus*; when two are joined together, they have been called *thus masculum*, and when very large, *thus femininum*: sometimes four or five, about the bigness of filberds, are found adhering to a piece of the bark of the tree which they exuded from; these have been named *thus corticosum*: the finer powder which rubs off from the tears in the carriage, *mica thuris*; and the coarser powder, *stannata thuris*. This drug is not however in any of its flats which is now called *thus* or *frankincense* in the shops. See the article *THUS*.

Olibanum consists of about equal parts of a gummy and resinous substance; the first soluble in water, the other in rectified spirit. With regard to its virtues, abundance have been attributed to it, particularly in disorders of the head and breast, in hæmoptoes, and in alvine and uterine fluxes: but its real effects in these cases are far from answering the promises of the recommenders. Riverius is said to have had large experience of the good effects of this drug in pleurisies, especially epidemic ones: he directs a scooped apple to be filled with a dram of olibanum, then covered and roasted under the ashes; this is to be taken for a dose, three ounces of carduus water after it, and the patient covered up warm in bed; in a short time, he says, either a plentiful sweat, or a gentle diarrhœa, ensues, which carry off the disease. Geoffroy informs us, that he has frequently made use of this medicine after venesection, with good success; but acknowledges that it has sometimes failed.

OLIGÆDRA, in natural history, the name of a genus of crystals composed of very few planes, as the name expresses. The bodies of this class are crystals of the imperfect kind; being composed of columns affixed irregularly to some solid body at one end, and the other terminated by a pyramid: but the column and pyramid being both pentangular, the whole consists only of ten planes, and not, as the common kind, of 12.

OLIGARCHY, a form of government, where-in the administration of affairs is confined to a few hands.

OLISIPO, (Pliny, Antonine, Inscriptions); a town of Lusitania, situate on the north side of the frith of the Tagus; of such antiquity, that Solinus thought it was built by Ulysses: and Mela, probably to favour this opinion, writes, according the common copies, *Ulyssipo*: both of them perhaps deceived by the similarity of sound. It was a municipium, with the surname *Felicitas Julia*, a privilege granted by the munificence

Olfactory  
||  
Oliipo.

Olio  
||  
Olympia.

nificance of Augustus, (Inscriptions, Pliny.) Now *Lisbon*, capital of Portugal, situate on the north bank of the Tagus, distant about ten miles from its mouth.

OLIO, in cookery, denotes a savoury dish composed of a great variety of ingredients, chiefly used by the Spaniards.

OLIVE, in botany. See OLEA.

Plate CCL  
fig. 3.

OLIVE-*Press*. In order to obtain the olive oil, the olives are first bruised in a rough trough, under a mill-stone, rolling perpendicularly over them; and when sufficiently mashed, put into the maye, or trough, *m*, of an olive-press, where *aa* are the upright beams, or cheeks; *b*, the female, and *c*, the male screw; *f*, the board on which the screw presses; *g*, a circular piece of wood, called a *block*; *h*, the peel, a circular board, to be put under the block. By turning the screw, all the liquor is pressed out of the mashed olives, and is called *virgin-oil*; after which, hot water being poured upon the remainder in the press, a coarser oil is obtained. Olive-oil keeps only about a year, after which it degenerates.

OLIVE-*Colour*, a yellow mingled with black.

OLIVER (Isaac), an excellent English painter, born in 1556; eminent both for history and portraits. Several fine miniatures of this master are to be seen in the collections of our nobility and gentry; some of them portraits of himself. As he was a very good designer, his drawings are finished to an extraordinary degree of perfection; many being copies after Parmegiano. Rubens and Vandeyck painted James I. after a miniature of Oliver's, which is a sufficient testimony of his merit. He died in 1617.

OLIVER (Peter), the son and disciple of Isaac Oliver, was born in 1601. He arrived at a degree of perfection in miniature portraits confessedly superior to his father, or any of his contemporaries; as he did not confine his subjects to a head only. In the collections of Charles I. and James II. there were 13 historical subjects painted by this Oliver; of which seven are still preserved in the closet of queen Caroline at Kensington: and a capital painting of his wife is in the possession of the dukes of Portland. He died in 1660.

OLIVET, or *Mount of Olives*, (anc. geog.), a mount which lay a little without Jerusalem, on the east side (Zechar. xiv.); separated from it by a deep valley called *Kedron*, (Josephus), or the valley of Jehosaphat; distant about eight furlongs or a mile from Jerusalem, (Luke); five furlongs, (Josephus); which may be understood of the nearer part of the mount.

OLMUTZ, a town of Germany, in Moravia, with a bishop's see, and a famous university. The public buildings are very handsome, particularly the Jesuits college. It is a populous, trading, and very strong place; and yet it was taken, with the whole garrison, by the king of Prussia in 1741. In July 1758, he besieged it again; and when he had almost taken the place, he was obliged to raise the siege, to go and meet the Russian army. It is seated on the river Morave. E. Long. 17. 35. N. Lat. 49. 30.

OLYMPIA, (anc. geog.), with the surname *Pri-fatis*, (Strabo); so called from the territory of Pifa in Elis; described by Strabo, "as the temple of Jupiter Olympius, before which stands a grove of wild olive-trees, in which is the stadium, or foot-course, so call-

ed, because the eighth part of a mile; and by which the Alpheus, coming down from Arcadia, runs." A temple and shrine highly ennobled by gymnastic exercises; and distinguished by a peculiar degree of veneration, and still more so by the statue of Jupiter, the work of Phidias, (Mela): situated between Olla and Olympius, mountains cognominal with those of Thesfally, distant 12 miles from Pylos; famous for games called the *Olympian*, celebrated the beginning of each fifth year, by which Greece computed time, (Pliny); a period of four years complete being called an *Olympiad*. Olympia was anciently called *Pifa*, or Pifa stood in its neighbourhood; and there Jupiter Olympius was worshipped. Historians take no notice of Pifa, though poets do, but only of Olympia: which is thought to have arisen, if it had ever any habitations, (so as to become a town or village, besides the temple and place of exercise,) from the ruins of Pifa; destroyed by the Eleans, according to Pausanias; who adds, that not a vestige either of the houses or walls was to be seen, but a plantation of vines on the spot where it stood. Again, Olympia and Pifa are said to have stood on different spots, but in each other's adjacency. The public edifices of Olympia were the temple of Jupiter, the gymnasium, the portico, the dwellings of the Athletes, the stadium or raised causeway, the Hippodromus or chariot-course, the barrier and goal. *Olympiacus*, (Virgil); *Olympicus*, (Horace); the epithets. Now called *Longinico*, in the Morea: E. Long. 22. o. N. Lat. 37. 30.

OLYMPIAD, the space of four years, whereby the Greeks reckoned time.

OLYMPIC GAMES, were solemn games among the ancient Greeks, so called from Olympian Jupiter, to whom they were dedicated; and by some said to be first instituted by Jupiter, after his victory over the sons of Titan; others ascribe their institution to Hercules, not the son of Alcmena, but one of much greater antiquity; others to Pelops; and others to Hercules the son of Alcmena. These games were so considerable, that the Greeks made them their epocha, distinguishing their years by the return of the Olympic games.

The care and management of the Olympics belonged for the most part to the Eleans; who, on that account, enjoyed their possessions without molestation or fear of war or violence. They appointed a certain number of judges, who were to take care that those who offered themselves as competitors should perform their preparatory exercises; and these judges, during the solemnity, sat naked, having before them a crown of victory, formed of wild olive, which was presented to whomsoever they adjudged it. Those who were conquerors were called *Olympionices*, and were loaded with honours by their countrymen. At these games women were not allowed to be present; and if any woman was found, during the solemnity, to have passed the river Alpheus, she was to be thrown headlong from a rock.

OLYMPUS, the name of several mountains; one bounding Bithynia on the south. Another in the island of Cyprus, on whose top was a temple of Venus, which women were not permitted either to enter or to see, (Strabo.) A third Olympus of Galatia, (Liv.) A fourth, of Lycia, with a noble cognominal town,

near

Olympia  
Olympus.

Ombre.

near the sea-coast, (Strabo, Cicero); extinct in Pliny's time, there remaining only a citadel: the town was destroyed by P. Servilius Iſauricus, (Florus); having been the retreat of pirates. From this mountain there was an extensive prospect of Lycia, Pamphylia, and Pifiidia, (Strabo.) A fifth Olympus of Mylia, (Ptolemy); thence furnished *Olympena*, anciently *Minor*; one of the highest mountains, and surnamed *Myſius*, (Theophrastus); situate on the Propontis, and thence extending more inland. A sixth, on the north of Thelſaly, or on the confines of Macedonia; famous for the fable of the giants, (Virgil, Horace, Seneca); reckoned the highest in the whole world, and to exceed the flight of birds, (Apuleius); which is the reason of its being called *heaven*, than which nothing is higher: the serenity and calmness which reign there are celebrated by Homer, Lucan, and Claudian.

OMBRE, a celebrated game at cards, borrowed from the Spaniards, and played by two, by three, or by five persons, but generally by three. When three play at this game, nine cards are dealt to each party; the whole ombre pack being only 40; because the eights, nines, and tens are thrown out of the pack. There are two sorts of counters for stakes, the greater and the lesser; the last having the same proportion to the other, as a penny to a shilling: of the greater counters each man stakes one for the game; and one of the lesser for passing, for the hand when eldest, and for every card taken in. As to the order and value of the cards, the ace of spades, called *spadillo*, is always the highest trump, in whatsoever suit the trump be; the *manille*, or black-duce, is the second; and the *basfo*, or ace of clubs, is always the third: the next in order is the king, the queen, the knave, the seven, the six, the five, four, and three. Of the black there are 11 trumps; of the red, 12. The least small cards of the red are always the best, and the most of the black; except the duce and red seven, both of which are called the *manilles*, and are always second when the red is a trump. The red ace, when a trump, enters into the fourth place, and is called *punto*, otherwise it is only called an *ace*. The three principal cards are called *matadores*; which have this privilege, that they are not obliged to attend an inferior trump when it leads; but for want of a small trump, the person may renounce trumps, and play any other card; and when these are all in the same hand, the others pay three of the greater counters a-piece; and with these three for a foundation, he may count as many *matadores* as he has cards in an uninterrupted series of trumps; for all which the others are to pay one counter a-piece. He who hath the first hand is called *ombre*, and has his choice of playing the game, of naming the trump, and of taking in as many and as few cards as he pleases; and after him the second, &c. But if he does not name the trump before he look on the cards he has taken in, any other may prevent him, by naming what trump he pleases. He that has the first hand, should neither take in, nor play, unless he has at least three sure tricks in his hand: for, as he wins the game who wins most tricks, he that can win five of the nine has a sure game; which is also the case if he wins four, and can so divide the tricks as that one person may win two, and the other three.

If a person plays without discarding or changing

any cards, this is called *playing sans prendre*; and if another wins more tricks than he, he is said to win *codile*. The over-fights in the course of the game, are called *beasts*. And if the ombre wins all the nine tricks, it is called *winning the vole*.

In ombre by five, which many, on account of its not requiring to close an attention, prefer to that by three, only eight cards a-piece are dealt; and five tricks must be won, otherwise the ombre is beaten. Here, the person who undertakes the game, after naming the trump, calls a king to his assistance; upon which the person in whose hand the king is, without discovering himself, is to assist him as a partner, and to share his fate. If, between both, they can make five tricks, the ombre wins two counters, and the auxiliary king only one; but when the counters are even, they divide them equally. If the ombre venture the game without calling in any king, this too is called *playing sans prendre*; in which case other four are all against him, and he must win five tricks alone, or be beaten. The rest is much the same as by three.

OMBRE *de soleil*, "Shadow of the sun," in heraldry, is when the sun is borne in armory, so as that the eyes, nose, and mouth, which at other times are represented, do not appear; and the colouring is thin, so that the field can appear through it.

OMBRIA, the ancient name of a province of Italy, in the territory of the pope, now called *Spoletto* and *Perugia*.

OMBRO, or LOMBARO, a town of Italy, in the duchy of Tuscany, and territory of the Siennesis, situated near the Tufcan sea, a little south of the lake of Cadiglione, 45 miles south-west of Sienna.

OMELET, or AMLET, a kind of pancake or fricasse of eggs, with other ingredients, very usual in Spain and France. It may be made as follows: the eggs being beaten, are to be seasoned with salt and pepper, and then fried in butter made boiling hot; this done, gravy is to be poured on, and the whole stewed with chives and parsley shred small: when one side is fried enough, it is to be turned on the other.

OMEN, a certain accident and casual occurrence, that was thought to preface either good or evil. There were three sorts of omens among the ancients: one was of things internal, or those which affected the persons themselves; the second, of things external, that only appeared to men, but did not make any impression on them; the third were ominous words. Of the first sort were those sudden confutations, called *panic fears*, that seized upon men without any visible cause, and were therefore imputed to the demons, especially the god Pan: of these panics there is frequent mention in history. The second sort of omens were of such things as appeared to men, but were not contained in their own bodies: of these there were several sorts; the beginning of things were thought to contain something ominous; it was thought a direful omen, when any thing unusual befel the temples, altars, or statues of the gods: under the head of external omens are to be placed those which offered themselves in the way; such were the meeting of an eunuch, a black, a bitch with whelps, a snake lying in the road, &c. Words were ominous, and, as they were good or bad, were believed to preface accordingly

Ombre  
||  
Omen.

Omentum ingly.

Onania.

OMENTUM, or EPILOON, the *Cawl*, in anatomy, a membranaceous part, usually furnished with a large quantity of fat; being placed under the peritonæum, and immediately above the intestines. See ANATOMY, n<sup>o</sup> 351.

OMBROMETER, a machine to measure the quantity of rain that falls. We have the description and sign of one in Phil. Trans. n<sup>o</sup> 473. p. 12. It consists of a tin funnel, whose surface is an inch square, with a flat board, and a glass tube set into the middle of it in a groove. The rise of the water in the tube, whose capacity at different times must be measured and marked, shews the quantity of rain that has fallen.

OMOPHAGIA, an ancient Greek festival, in honour of Bacchus, surnamed *Omophagos*, i. e. eater of raw-flesh. This festival was observed in the same manner with the other festivals of Bacchus, in which they counterfeited madness; what was peculiar to it, was, that the worshippers used to eat the entrails of goats, raw and bloody, in imitation of the god, who was supposed to do the same thing.

OMPHALMO-MESENERIC, in anatomy. All testicles are wrapped up in at least two coats or membranes; most of them have a third, called *allantoides*, or *urinary*.

Some, as the dog, cat, hare, &c. have a fourth, which has two blood-vessels, viz. a vein and an artery, called *omphalo-mesenteric*, because passing along the string to the navel, and terminating in the mesentery.

ON, (anc. geog.), a town of Egypt towards Arabia, to the south-east of Babylon, and of the eastern branch of the Nile. The prophet Jeremiah calls it the house or town of the sun, in the land of Egypt. The high-priest Onias built a temple here, held in great esteem by the Hellenists.

ONANIA, or ONANISM, terms lately framed to denote the crime of self-pollution, mentioned in scripture to have been committed by Onan, and punished in him with death.

This practice, however common, hath among all nations been reckoned a very great crime. In scripture, besides the instance of Onan abovementioned, we find self-polluters termed *effeminate*, *unclean*, *filthy*, and *abominable*. Even the heathens, who had not the advantage of revelation, were of the same opinion, as appears from the following lines of Martial.

*Hoc nihil esse putas! scelus est; mihi crede, sed ingens  
Quantum vix animo concipis ipse tuo.*

You think 'tis nothing! 'tis a crime, believe!  
A crime so great you scarcely can conceive.

Dr Tissot has published a treatise on the pernicious effects of this shameful practice, which appears to be no less baneful to the mind than to the body. He begins with observing, that, by the continual waste of the human body, aliments are required for our support. These aliments, however, require certain preparation in the body itself; and when by any means we become so altered that these preparations cannot be effected, the best aliments then prove insufficient for the support of the body. Of all the causes by which this morbid alteration is brought on, none is more common than

too copious evacuations; and of all evacuations, that of the semen is the most pernicious when carried to excess. It is also to be observed, that though excess in natural venery is productive of very dangerous disorders, yet an equal evacuation by self-pollution, which is an unnatural way, is productive of others still more to be dreaded. The consequences enumerated by Dr Tissot are as follow.

1. All the intellectual faculties are weakened; the memory fails; the ideas are confused, and the patient sometimes even falls into a slight degree of insanity. They are continually under a kind of inward rëflexions, and feel a constant anguish. They are subject to giddiness; all the senses, especially those of seeing and hearing, grow weaker and weaker, and they are subject to frightful dreams.

2. The strength entirely fails, and the growth in young persons is considerably checked. Some are afflicted with almost continual watching, and others do almost perpetually. Almost all of them become hypochondriacs or hysterical, and are afflicted with all the evils which attend these disorders. Some have been known to spit calcareous matter; and others are afflicted with coughs, slow fevers, and consumptions.

3. The patients are affected with the most acute pains in different parts of the body, as the head, breast, stomach, and intestines; while some complain of an obtuse sensation of pain all over the body, on the slightest impression.

4. There are not only to be seen pimples on the face, which are one of the most common symptoms; but even blotches, or suppurative pustules, appear on the face, nose, breast, and thighs; and sometimes fleshy excrescences arise on the forehead.

5. The organs of generation are also affected; and the semen is evacuated on the slightest irritation, even that of going to stool. Numbers are afflicted with an habitual gonorrhœa, which entirely destroys the vigour of the constitution, and the matter of it resembles a fetid sanies. Others are affected with painful priapisms, dysuries, stranguries, and heat of urine, with painful tumours in the testicles, penis, bladder, and spermatic cord.

6. The functions of the intestines are sometimes totally destroyed; and some patients complain of colicness, others of diarrhœa, piles, and the running of a fetid matter from the fundament.

With regard to the cure, the first step is to leave off those practices which have occasioned the disease: which our author asserts is no easy matter; as, according to him, the soul itself becomes polluted, and can dwell on no other idea; or if she does, the irritability of the parts of generation themselves quickly recal ideas of the same kind. This irritability is no doubt much more to be dreaded than any pollution the soul can have received; and by removing it, there will be no occasion for exhortations to discontinue the practice. The principal means for diminishing this irritability are, in the first place, to avoid all stimulating, acrid, and spiced meats. A low diet, however, is improper, because it would further reduce the body already too much emaciated. The food should therefore be nutritive, but plain, and should consist of flesh rather roasted than boiled, rich broths, &c. It is certain,

Onania.

Onea  
Oneroica  
critica.

tain, however, that as these foods contribute to restore the strength of the body, the stimulus on the organs of generation will be proportionally increased, by the semen which is constantly secreted, and which will now be in larger quantity than even in healthy persons, owing to the great evacuations of it which have preceded. Some part of the semen is gradually absorbed by the lymphatics; in consequence of which, the remainder becomes thick, acrid, and very stimulating. To remedy this, exercise is to be used, and that not only for pleasure, but till it is attended with a very considerable degree of fatigue. The sleep also must be no more than is barely sufficient to repair the fatigues occasioned by the exercise, or other employment; for an excess in sleep is as bad as idleness or stimulating foods. Excess in wine or intoxicating liquors is also to be avoided; or rather such liquors ought never to be tasted, unless as a medicine to restore the exhausted spirits; and to all this ought to be joined the Peruvian bark, which hath this admirable property, that, with little or no stimulus, it restores the tone of the system, and invigorates the body in a manner incredible to those who have not observed its effects. If these directions are followed, the patient may almost certainly expect a recovery, provided any degree of vital strength remains; and those who desire a life of celibacy on a moral account, will find them much more effectual than all the vows of chastity they can make.

ONCA, or ONCS, in zoology. See FELIS.

ONEGA, a river and lake of the Russian empire, between Muscovite Carelia, the territory of Cargopol, and Swedish Carelia. It is 100 miles in length and 40 in breadth, having a communication with the lake Ladoga, and consequently with Peterburgh. The river has its source in Cargopol, and gives its name to a country full of woods.

ONEGLIA, a sea-port town of Italy, in the territory of Genoa, with the title of a principality; but it belongs to the king of Sardinia, as well as the province, which abounds in olive-trees, fruit and wine. It has often been taken and retaken in the wars of Italy; which is no wonder, as it is an open place. The French and Spaniards had possession of it in 1744, but were driven out by the Piedmontese; however, they returned next winter, and again made themselves masters of it. E. Long. S. 1. N. Lat. 43. 55.

ONEIROCRITICA, the art of interpreting dreams; or a method of foretelling future events by means of dreams. See DREAM, DIVINATION, &c.—The word is formed from the Greek *ονειρος*, "dream," and *κρισις*, of *κρισις*, "judgment."—Some call it *oneirocritica*; and derive it from *ονειρος*, and *κρισις*, "I possess, I command."

It appears from several passages of scripture, that there was, under the Jewish dispensation, such a thing as foretelling future events by dreams; but then there was a particular gift, or revelation, required for that purpose.

Hence it has been inferred, that dreams are really significative, and do forebode something to come; and all that is wanting among us is the *oneirocritica*, or the art of knowing what: yet it is the opinion of many, that dreams are mere chimeras; bearing, indeed, some relation to what has passed, but none to what is to

come.—As to the case of Joseph, it was possible for God, who knew all things, to discover to him what was in the womb of fate; and to introduce that, he might take the occasion of a dream.

ONEIROCRITICS, a title given to interpreters of dreams, or those who judge of events from the circumstances of dreams.

There is no great regard to be had to those Greek books called *oneirocriticæ*; nor do we know why the patriarch of Constantinople; and others, should amuse themselves with writing on so pitiful a subject.

Rigault has given us a collection of the Greek and Latin works of this kind; one attributed to Astrampichus; another to Nicephorus, patriarch of Constantinople; to which are added the treatises of Artemidorus and Achmet.—But the books themselves are little else than reveries; a kind of waking dreams, to explain and account for sleeping ones.

The secret of oneirocriticism, according to them all, consists in the relation supposed to be between the dream, and the thing signified: but they are far from keeping to the relations of agreement and similitude; and frequently have recourse to others of dissimilitude, and contrariety.

ONESIE THERMÆ, (Strabo;) who calls them *excellent baths, and salutary waters*, at the foot of the Pyrenæes in Aquitania. Near the river Aturus stands at this day the town Bagneres, famous for its waters, which appear to be the *Onesie* of Strabo; situate in the county of Bigorre in Gascony, near the river Adour.

ONIE OPPIDUM and *Templum*, (Josephus;) so called from Onias, the high-priest of the Jews in Egypt; who built a temple in imitation of that at Jerusalem, by permission of the king of Egypt, on the spot where stood the temple of Diana Agrestis in Leontopolis: it was encompassed with a brick wall, and had a large tower like that at Jerusalem, (Josephus;) it was the metropolis of the Nomos Heliopolites, (Ptolemy;) because in Strabo's time Heliopolis was fallen to decay.

ONGLEE, in heraldry, an appellation given to the talons or claws of beasts or birds, when borne of a different colour from that of the body of the animal.

ONION. See CEPÆ.—Onions, leeks, and garlic, are all of the same genus; and in their recent state are acrid, but harmless to the human body. When, by age or climate, this acrimony is too great, we do not use them as food. In Spain, the garlic being equally mild with the onion is used as common food. By the ordinary culinary preparation their acrimony is dissipated, and a remarkably mild substance remains, promising much nutriment, which those who can digest them raw will certainly obtain. Though sometimes shunned as food, yet they are on that account used in medicine, uniting the two qualities of pectorals, viz. on the account of their acrimony, being in their recent state expectorant; in their boiled state, on account of their mucilage, demulcent, provided the quantity taken be sufficient. Some of late, in this country, have found in leeks a somniferous quality; but this is not yet confirmed by a sufficient number of experiments.—Besides the three abovementioned, there are several

Oneroica  
critica  
Onion.



Oniscus,  
Onkelos.

several others belonging to the same tribe, which we use as condiment; but only the leek and onion as diet. In its recent state, the onion is the most acrid; in its boiled state, the leek retains its acrimony most tenaciously. On account of this, and some difference of texture, the onion is more easily digested, and more universally used, than the leek; being more easily broke down, and more generally agreeable.

ONISCUS, in zoology, a genus of insects belonging to the order of aptera. It has 14 legs, bristly feelers, and an oval body. There are 15 species; of which the most remarkable are, 1. The entomon, or sea wood-louse, is white; eyes black; convex above, beneath flat, margin acute: Antennæ 4: Four hind pair of legs largest, hairy. Body of 7 segments. Length  $\frac{1}{2}$  line. Found on the coast. It accompanies the herring, and is an enemy well known to our fishermen: these insects will frequently eat up a whole fish while it hangs in the net.—2. Afellus, millepes, or wood-louse, is oval; the tail obtuse, with 2 undivided bristles: Various as to colour: Length, 5 lines. Their use in medicine is well known.

ONKELOS, surnamed the *Profelyte*, a famous rabbi of the first century, and the author of the Chaldee Targum on the Pentateuch. He flourished in the time of Jesus Christ, according to the Jewish writers; who all agree, that he was, at least in some part of his life, contemporary with Jonathan Ben Uzziel, author of the second Targum upon the prophets. Dean Prideaux thinks he was the elder of the two, for several reasons: the chief of which is the purity of the style in his Targum, therein coming nearest to that part of Daniel and Ezra which is in Chaldee, and is the truest standard of that language, and consequently is the most ancient; since that language, as well as others, was in a constant flux, and continued deviating in every age from the original: nor does there seem to be any reason why Jonathan Ben Uzziel, when he understood his Targum, should pass over the law, and begin with the prophets, but that he found Onkelos had done this work before him, and with a success which he could not exceed.

Azarias, the author of a book, intitled *Meor Enaim*, or the *Light of the Eyes*, tells us, that Onkelos was a profelyte in the time of Hillel and Samnai, and lived to see Jonathan Ben Uzziel one of the prime scholars of Hillel. These three doctors flourished 12 years before Christ, according to the chronology of Gauz; who adds, that Onkelos was cotemporary with Gamaliel the elder, St Paul's master, who was the grandson of Hillel, who lived 28 years after Christ, and did not die till 18 years before the destruction of Jerusalem. However, the same Gauz, by his calculation, places Onkelos 100 years after Christ; and to adjust his opinion with that of Azarias, extends the life of Onkelos to a great length. The Talmudists tell us that he assisted at the funeral of Gamaliel, and was at a prodigious expence to make it most magnificent. Dean Prideaux observes, that the Targum of Onkelos is rather a version than a paraphrase; since it renders the Hebrew text word for word, and for the most part accurately and exactly, and is by much the best of all this sort: and therefore it has always been held in esteem among the Jews, much above all the other Targums; and being set to the same musical notes with the

Hebrew text, it is thereby made capable of being read in the same tone with it in their public assemblies. From the excellency and accuracy of Onkelos's Targum, the dean also concludes him to have been a native Jew, since, without being bred up from his birth in the Jewish religion and learning, and long exercised in all the rites and doctrines thereof, and being also thoroughly skilled in both the Hebrew and Chaldee languages, as far as a native Jew could be, he can scarce be thought thoroughly adequate to that work which he performed; and that the representing him as a profelyte, seems to have proceeded from the error of taking him to have been the same with Akilas, or Aquila, of Pontus, author of the Greek Targum or version of the prophets and Hagiographia, who was indeed a Jewish profelyte.

ONKOTOMY, in surgery, the opening of a tumour or abscess. See SURGERY.

ONOMANCY, or rather ONOMAMANCY, a branch of divination, which foretells the good or bad fortune of a man, from the letters in his name. See the article DIVINATION.

From much the same principle the young Romans toasted their mistresses as often as there were letters in their names: hence Martial says,

*Nevia, sex cyathis, septem Julina bibatur.*

ONOMATOPOEIA, in grammar and rhetoric, a figure where words are formed to resemble the sound made by the things signified; as the buzz of bees, the cackling of hens, &c.

ONOSANDER, a Greek author and Platonic philosopher, who wrote Commentaries on Plato's politics, which are lost: but his name is particularly famous for a treatise intitled *Δεσος Στρατηγικος*, "Of the duty and virtues of the general of an army;" which has been translated into Latin, Italian, Spanish, and French. The time when he lived is not precisely known; but is imagined to be in the reign of the emperor Claudius.

ONTARIO, a lake of North America, in the country of the Iroquois, 180 miles in length and 60 in breadth. There are many rivers that run into it; and from it the great river St Lawrence proceeds. It communicates with lake Erie by a river 33 miles in length, in which is the remarkable cataract of NIAGARA.

ONTOLOGY. See METAPHYSICS, n<sup>o</sup> 1.

ONUPHRIUS PANVINUS, a learned Italian, of the order of hermits of St Augustine, was born of a noble family at Verona, in 1529; and, being trained to literature, became so indefatigable in his studies, that he spent whole days and nights in reading the ancients: which made Manutius style him *Hellas Antiquitatis*. His first performance was A Chronicle of Popes and Cardinals, which was printed without his knowledge at Venice in 1557; and some time after, more correctly by himself. He afterwards continued Platina's Lives of the Popes, from Sextus IV. to Pius V. and subjoined annotations to the lives Platina had written. He also wrote four pieces upon Roman Antiquities, which are printed in Grævius's Collection. He died in his 39th year, in 1568.

ONYCOMANCY, or, as some write it, ONYMANCY; a kind of divination by means of the nails of the fingers.—The word is formed from the Greek *ονος*, "nail," and *μαντικα*, "divination."

Oncotomy  
Onycomancy.

The ancient practice was to rub the nails of the hands with oil and foot, or wax; and to hold up the nails thus smeared against the sun.—Upon them were supposed to appear figures or characters, which shewed the thing required.

**ONYX**, in natural history, one of the fempellucid gems, with variously coloured zones, but none red; being composed of crystal, defaced by a small admixture of earth; and made up either of a number of flat plates, or of a series of coats surrounding a central nucleus, and separated from each other by veins of a different colour, resembling zones or belts.

We have four species of this gem. 1. A bluish-white one, with broad white zones. 2. A very pure onyx, with snow-white veins. 3. The jasponyx, or horny-onyx, with green zones. 4. The brown onyx, with bluish-white zones.

The ancients attributed wonderful properties to the onyx, and imagined that if worn on the finger it acted as a cardiac; they have also recommended it as an astringent: but at present no regard is paid to it.

The word in the Greek language signifies *nail*; the poets making this stone to have been formed by the Parca; from a piece of Venus's nails, cut off by Cupid with one of his arrows.

**OOST**, a kiln for drying hops after they are picked from the stalks.

**OPACITY**, in philosophy, a quality of bodies which renders them impervious to the rays of light.

**OPAL**, in natural history, a species of the chroaltes genus of gems.

The opal is a gem of a very peculiar kind, and has been esteemed by many in all ages of very great value; though at present it is of less value, in proportion to its size, than any of the finer gems. It is softer than any other of the fine gems, and is difficult to polish to any degree of nicety. It is found of various shapes and sizes; its most frequent bigness is between that of a pea and a horse-bean; but it is found as small as the head of a large pin, and has been seen of the size of a large walnut. Its figure is very various and uncertain, but it is never found in a crystalliform or columnar state; its most usual shape is an irregular oblong one, convex above, flattened at bottom, and dented with various sinuities at its sides. It is often found among the loose earth of mountains, sometimes on the shores of rivers, and not unfrequently bedded in the coarser kinds of Jasper. It is found in Egypt, Arabia, some parts of the East Indies, and in many parts of Europe: those of Europe are principally from Bohemia, and are of a greenish or greyish colour; the colour of the other opals much resembles the finest mother of pearl, its basis seeming a bluish or greyish white, but with a property of reflecting all the colours of the rainbow, as turned differently to the light.

**OPALIA**, in antiquity, feasts celebrated at Rome in honour of the goddess Ops. Varro says they were held on the 19th of December, which was one of the days of the saturnalia: these two feasts were celebrated in the same month, because Saturn and Ops were husband and wife: the vows offered to the goddesses were made sitting on the ground.

**OPERA**, a dramatic composition set to music, and sung on the stage, accompanied with musical instru-

ments, and enriched with magnificent dresses, machines, and other decorations. See **POETRY**, ch. ii. and **MUSIC**, n° 26.

**OPERATION**, in general, the act of exerting or exercising some power or faculty, upon which an effect follows.

**OPERATION**, in surgery and medicine, denotes a methodical action of the hand on the human body, in order to re-establish health.

**OPHIDIUM**, a genus of fishes belonging to the order of apodes. The head is somewhat naked; the teeth are in the jaws, palate, and fauces; there are seven rays in the gill-membranes; and the body is shaped like a sword. There are two species.

**OPHIOGLOSSUM**, **ADDER'S TONGUE**; a genus of the order of filices, belonging to the cryptogamia class of plants. There are seven species; of which the only remarkable one is the vulgatum, or common adder's-tongue, which is a native of several places of Britain, growing in meadows and moist pastures. The country-people make an ointment of the fresh leaves, and use it as a vulnerary to green wounds; which is a very ancient application, recommended by Matthiolus, Tragus, and others.

**OPHIOMANCY**, in antiquity, the art of making predictions from serpents. Thus Calchas, on seeing a serpent devour eight sparrows with their dam, foretold the duration of the siege of Troy; and the seven coils of a serpent that was seen on Anchises's tomb, were interpreted to mean the seven years that Æneas wandered from place to place before he arrived at Latium.

**OPHIORHIZA**, in botany, a genus of the monogynia order, belonging to the pentandria class of plants. There are two species; the most remarkable of which is the Asiaticum, or true lignum colubrinum. The root of this is known in the East Indies to be a specific against the poison of that most dreadful animal called the hooded serpent. There is a treatise in *Ann. Acad. tom. iv.* upon this subject, wherein the author Joh. And. Darcilius undertakes, from the description of such authors as had seen it upon the spot, to ascertain the plant from which the genuine root is taken. It appears in this account, that it had puzzled the European physicians; and what had been sold in the shops for it, is the root of a very different plant, and of a poisonous nature.

The true root is called *mungus*, for the following reason.—There is a kind of weasel in the East Indies, called *mungutia* by the natives, *mungo* by the Portuguese, and *muncas* by the Dutch. This animal pursues the hooded serpent, as the cat does the mouse with us. As soon as this serpent appears, the weasel attacks him; and if the chances be bit by him, she immediately runs to find a certain vegetable, upon eating which she returns, and renews the fight.—The Indians are of opinion that this plant is the mungus.

That celebrated traveller Kempfer, who kept one of these weasels tame, that eat with him, lived with him, and was his companion wherever he went, says he saw one of these battles between her and the serpent, but could not certainly find out what root the weasel looked out for. But whether the weasel first discovered this antidote or not, it is an infallible remedy

Ophites  
||  
Ophrys.

remedy against the bite of the hooded serpent. And this he undertakes to ascertain.

**OPHITES**, in natural history, a sort of variegated marble, of a dusky-green ground, sprinkled with spots of a lighter green, otherwise called *Serpentine*. See the article **MARBLE**.

**OPHITES**, in church-history, Christian heretics, so called both from the veneration they had for the serpent that tempted Eve, and the worship they paid to a real serpent: they pretended that the serpent was Jesus Christ, and that he taught men the knowledge of good and evil. They distinguished between *Jofus* and *Christ*: Jesus, they said, was born of the Virgin, but Christ came down from heaven to be united with him; Jesus was crucified, but Christ had left him to return to heaven. They distinguished the God of the Jews, whom they termed *Jaldabaath*, from the supreme God: to the former they ascribed the body, to the latter the soul of men. They had a live serpent, which they kept in a kind of cage; at certain times they opened the cage-door, and called the serpent: the animal came out, and, mounting upon the table, twined itself about some loaves of bread; this bread they broke and distributed it to the company, who all kissed the serpent: this they called their *Eucharist*.

**OPHIR**, a country mentioned in scripture, from which Solomon had great quantities of gold brought home in ships which he sent out for that purpose; but where to fix its situation is the great difficulty, authors running into various opinions on that head. Some have gone to the West, others to the East Indies, and the eastern coasts of Africa, in search of it. The generality place Ophir in the East Indies: but where there, is the question; many taking it for Taphrobana, now supposed to be Ceylon; others for Pegu, or for Sumatra; or for the Aurea Cherfonesus, now Malacca: unless *Aurea Cherfonesus* be, as many think, an appellative common to all countries producing gold. Kircher takes the term *Ophir* to be of Egyptian original, and to denote a great part of India: and, to obviate difficulties, perhaps it is best to take *Ophir* for India at large, without confining it to any particular country, not excluding even China and the Japanese islands.

**OPHRYS**, TWYBLADE; a genus of the diandria order, belonging to the gynandria class of plants. The species are numerous; but the most remarkable are the following.

1. The *ovata*, oval-leaved ophrys, or common twyblade, hath a bulbous, fibrated root; crowned by two oval, broad, obtuse, veined, opposite leaves; an erect, succulent, green stalk, six or eight inches high, naked above, and terminated by a loose spike of greenish flowers, having the lip of the nectarium bifid. The flowers of this species resemble the figure of gnats.

2. The *spiralis*, spiral orchis, or triple ladies-tresses, hath bulbous, oblong, aggregated roots; crowned by a cluster of oval, pointed, ribbed leaves; erect simple stalks, half a foot high; terminated by long spikes of white odoriferous flowers, hanging to one side, having the lip of the nectarium entire, and crenated.

3. The *nidus-avis*, or bird's-nest, hath a bulbous, fibrated, clustered root; upright, thick, succulent stalks, a foot high, sheathed by the leaves, and terminated by loose spikes of pale-brown flowers; having

the lip of the nectarium bifid. 4. The anthropophora, man-shaped ophrys, or man-orchis, hath a roundish bulbous root, crowned with three or four oblong leaves; upright thick stalks, rising a foot and a half high; adorned with narrow leaves, and terminated by loose spikes of greenish flowers, representing the figure of a naked man; the lip of the nectarium linear tripartite, with the middle segment longest and bifid. There is a variety with brownish flowers tinged with green. 5. The insectifera, or insect-orchis, hath two roundish bulbous roots, crowned with oblong leaves; erect leafy stalks, from six to 10 or 12 inches high, terminated by spikes of insect-shaped greenish flowers, having the lip of the nectarium almost five-lobed. This wonderful species exhibit flowers in different varieties, that represent singular figures of flies, bees, and other insects; and are of different colours in the varieties. 6. The monorchis, or mulky ophrys, hath a roundish bulbous root; crowned with three or four oblong leaves; an erect naked stalk, six inches high; terminated by a loose spike of yellowish, mulky-scented flowers.

All these six species of ophrys flower in summer, at different times in different sorts, from May until July; and in most of the sorts exhibit a singularly curious appearance. The plants are all perennial in root, which are of the bulbous fleshy kind, from which the flower-stalks rise annually in spring, and decay in autumn; at which period is the proper time for removing the roots from one place to another. They all grow wild in Britain, &c.; are residents of woods, bogs, marshy grounds, sterile pastures, chalky soils, and the like places, where they flourish and display their singular flowers in great abundance, from which places they are introduced into gardens for variety; and having procured some plants at the proper season, and planted them in soils and situations somewhat similar to that where they naturally grow, the roots will abide for several years, and flower annually.

As to their propagation, it may be tried by seed in a shady border, as soon as it is ripe; likewise by offsets from the root, though they multiply sparingly in gardens: however, roots of some standing may be examined at the proper season, and any off-sets separated and planted in the proper places.

**OPHTHALMOSCOPY**, a branch of physiognomy, which deduces the knowledge of a man's temper and manner from the appearance of his eyes.

**OPHTHALMIA**, in medicine, an inflammation of the membranes which invest the eye; especially of the adnata, or albugineous coat. See **MEDICINE**, n<sup>o</sup> 283.

**OPIATES**, medicines of a thicker consistence than a syrup, prepared with opium scarcely fluid. They consist of various ingredients, made up with honey or syrup; and are to be used for a long time either for purgative, alterative, or corroborative intentions.

The word *opiate* is also used, in general, for any medicine given with an intention to procure sleep, whether in the form of electuaries, drops, or pills.

**OPITS**, or **OPITIVS** (Martin), a celebrated German poet, born at Breslaw in 1507. He acquired great fame by his Latin, and more by his German poems; and, retiring to Dantzic, wrote a history of the ancient

Ophrys  
&  
Opits.

ancient Daci: he died of the plague in 1639.

OPITA (Henry), a learned Lutheran divine, born at Alenburg in Misnia in 1642. He was professor of theology and of the oriental languages at Kiel, where he acquired great reputation by a variety of excellent works concerning oriental literature and Hebrew antiquities. He died in 1712.

OPIUM, in the materia medica, is an inspissated juice, partly of the refinous and partly of the gummy kind, brought to us in cakes from eight ounces to a pound weight. It is very heavy, of a dense texture, and not perfectly dry; but, in general, easily receives an impression from the finger: its colour is a brownish yellow, so very dark and dusky that at first it appears black: it has a dead and faint smell, and its taste is very bitter and acrid. It is to be chosen moderately firm, and not too soft; its smell and taste should be very strong, and care is to be taken that there be no dirty or stony matter in it.

Opium is the juice of the papaver album, or white poppy, with which the fields of Asia Minor are in many places sown, as ours are with corn. When the heads are near ripening, they wound them with an instrument that has five edges, which on being stuck into the head makes at once five long cuts in it; and from these wounds the opium flows, and is next day taken off by a person who goes round the field, and put up in a vessel which he carries fastened to his girdle; at the same time that this opium is collected, the opposite side of the poppy-head is wounded, and the opium collected from it the next day. They distinguish, however, the produce of the first wounds from that of the succeeding ones; for the first juice afforded by the plant is greatly superior to what is obtained afterwards. After they have collected the opium, they moisten it with a small quantity of water or honey, and work it a long time upon a flat, hard, and smooth board, with a thick and strong instrument of the same wood, till it becomes of the consistence of pitch; and then work it up with their hands, and form it into cakes or rolls for sale.

Opium at present is in great esteem, and is one of the most valuable of all the simple medicines. Applied externally, it is emollient, relaxing, and discutient, and greatly promotes suppuration: if long kept upon the skin, it takes off the hair, and always occasions an itching in it; sometimes it exulcerates it, and raises little blisters, if applied to a tender part. Sometimes, on external application, it allays pain, and even occasions sleep: but it must by no means be applied to the head, especially to the futures of the skull; for it has been known to have the most terrible effects in this application, and even to bring on death itself. Opium, taken internally, removes melancholy, eases pain, and disposes to sleep; in many cases removes hæmorrhages, and provokes sweating. A moderate dose is commonly under a grain; though, according to the circumstances, two grains, or even three, may be within the limits of this denomination: but custom will make people bear a dram or more; though in this case nature is vitiated, and nothing is to be hence judged in regard to others. If given dissolved, it operates in half an hour; if in a solid form, as in pills, or the like, it is sometimes an hour and a half. Its first effect, in this case, is the making the patient cheerful, as if he had drank mo-

derately of wine, and at the same time bold and above the fear of danger; for which reason the Turks always take it when they are going to battle. A very immoderate dose brings on a sort of drunkenness, much like that occasioned by an immoderate quantity of strong liquors; cheerfulness and loud laughter at first, than a relaxation of the limbs, a loss of memory, and lightheadedness; then vertigoes, dimness of the eyes, with a laxity of the cornea and a dilatation of the pupils, a slowness of the pulse, redness of face, relaxation of the under-jaws, swelling of the lips, difficulty of breathing, painful erection of the penis, convulsions, cold sweat, and finally death. Those who escape are usually relieved by a great number of stools, or profuse sweats.

OPOBALSAMUM, in the materia medica. Opobalsam, or balm of Gilead; a resinous juice, obtained from an evergreen tree, or shrub, growing spontaneously in Arabia. The best sort, which naturally exudes from the plant, is scarce known to Europe; and the inferior kinds, said to be extracted by lightly boiling the leaves and branches in water, are very rarely seen among us. The true opobalsam, according to Alpinus, is at first turbid and white; of a very strong pungent smell, like that of turpentine, but much sweeter; and of a bitter, acrid, astringent taste; upon being kept for some times it becomes thin, limpid, light, of a greenish hue; then of a gold yellow; and at length of the colour of honey: after this it grows thick like turpentine, and loses much of its fragrance. This balsam is of great esteem in the eastern countries, both as a medicine, and as an odoriferous unguent and cosmetic. Its great scarcity has prevented its coming into use among us; in the mithridate and theriaca, which it is directed as an ingredient in, the London college allows the expressed oil of nutmegs as a succedaneum to it.

OPOPANAX, in the materia medica, is a gum resin of a tolerably firm texture, usually brought to us in loose granules or drops, and sometimes in large masses, formed of a number of these connected by a quantity of matter of the same kind; but these are usually loaded with extraneous matter, and are greatly inferior to the pure loose kind. The drops or granules of the fine opopanax, are on the outside of a brownish red colour, and of a dusky yellowish or whitish colour within: they are of a somewhat unctuous appearance, smooth on the surface; and are to be chosen in clear pieces, of a strong smell and acrid taste.

Opopanax is attenuating and discutient, and is gently purgative; it dispels flatulencies, and is good in asthma, in inveterate coughs, and in disorders of the head and nerves. It also promotes the menses, and is good against all obstructions of the viscera.

OPOSSUM, in zoology. See DIDELPHUS.

OPPIANUS, a poet and grammarian of Anazarba in Cilicia, in the second century. He composed a poem of hunting, and another of fishing, for which Antoninus Caracalla gave him as many golden crowns as there were verses in his poems; they were called hence *Oppian's golden verses*. He died in the 30th year of his age.

OPPIATION, in medicine, the act of obstructing or stopping up the passages of the body, by redundant

Optative. dundant or peccant humours. This word is chiefly used for obstructions in the lower belly.

OPTATIVE mood, in grammar, that which serves to express an ardent desire or wish for something.

In most languages, except the Greek, the optative is only expressed by prefixing to the subjunctive an adverb of wishing; as *utinam*, in Latin; *plut a Dieu*,

in French; and *would to God*, in English.

OPTIC ANGLE, the angle which the optic axes of both eyes make with one another, as they tend to meet at some distance before the eyes.

OPTIC Axis, the axis of the eye, or a line going through the middle of the pupil, and the centre of the eye.

O P T I C S;

THAT science which treats of æment of the light, and the various phenomena of vision.

H I S T O R Y.

§ 1. Discoveries concerning the Light.

THESE are enumerated under the article LIGHT so fully, that there is little room for any further addition here. The nature of that subtle element is indeed very little known as yet, notwithstanding all the endeavours of philosophers; and whatever side is taken with regard to it, whether we suppose it to consist of an infinity of small particles propagated by a repulsive power from the luminous body, or whether we suppose it to consist in the vibrations of a subtle fluid, there are prodigious difficulties, almost, if not totally insuperable, which will attend the explanation of its phenomena. In many parts of this work the identity of light and of the electric fluid is asserted: this, however, doth not in the least interfere with the phenomena of optics; all of which are guided by the same invariable laws, whether we suppose light to be a vibration of that fluid, or any thing else. We shall therefore proceed to,

§ 2. Discoveries concerning the Refraction of Light.

We find that the ancients, though they made very few optical experiments, nevertheless knew, that when light passed through mediums of different densities, it did not move forward in a straight line, but was bent, or *refracted*, out of its course. This was probably suggested to them by the appearance of a straight stick partly immersed in water; and we find many questions concerning this and other optical appearances in Aristotle; to which, however, his answers are insignificant. Archimedes is even said to have written a treatise concerning the appearance of a ring or circle under water, and therefore could not have been ignorant of the common phenomena of refraction. But the ancients were not only acquainted with these more ordinary appearances of refraction, but knew also the production of colours by refracted light. Seneca says, that if the light of the sun shines through an angular piece of glass, it will shew all the colours of the rainbow. These colours, however, he says are false, such as are seen in a pigeon's neck when it changes its position; and of the same nature he says is a *speculum*, which, without having any colour of its own, assumes that of any other body. It appears also, that the ancients were not unacquainted with the magnifying power of glass globes filled with water, though they do not seem to have known any thing of the reason of this power; and the ancient engravers are supposed to have made

use of a glass globe filled with water to magnify their figures, and thereby to work to more advantage. That the power of transparent bodies of a spherical form in magnifying or burning was not wholly unknown to the ancients, is farther probable from certain gems preserved in the cabinets of the curious, which are supposed to have belonged to the Druids. They are made of rock-crystal of various forms, amongst which are found some that are lenticular and others that are spherical: and though they are not sufficiently wrought to perform their office as well as they might have done if they had been more judiciously executed, yet it is hardly possible that their effect, in magnifying at least, could have escaped the notice of those who had often occasion to handle them; if indeed, in the spherical or lenticular form, they were not purposely intended for the purposes of burning. One of these, of the spherical kind, of about an inch and a half diameter, is preserved among the fossils given to the university of Cambridge by Dr Woodward.

The first treatise of any note written on the subject of optics, was by the celebrated astronomer Claudius Ptolemy, who lived about the middle of the second of Ptolemy's century. The treatise is lost; but from the accounts of others we find that he treated of astronomical refractions. Though refraction in general had been observed very early, it is possible that it might not have occurred to any philosophers much before his time, that the light of the sun, moon, and stars must undergo a similar refraction, in consequence of falling obliquely upon the gross atmosphere that surrounds the earth; and that they must, by that means, be turned out of their rectilinear course, so as to cause those luminaries to appear higher in the heavens than they would otherwise do. The first astronomers were not aware that the intervals between stars appear less near the horizon than in the meridian; and, on this account, they must have been much embarrassed in their observations. But it is evident that Ptolemy was aware of this circumstance, by the caution that he gives to allow something for it, upon every recourse to ancient observations.

This philosopher also advances a very sensible hypothesis to account for the remarkably greater apparent size of the sun and moon when seen near the horizon. The mind, he says, judges of the size of objects by means of a pre-conceived idea of their distance from us: and this distance is fancied to be greater when a number of objects are interposed between the eye and the body we are viewing; which is the case when we see the heavenly bodies near the horizon. In his *Almagest*, however, he ascribes this appearance to a refraction

1  
Great difficulties attend the explanation of the phenomena of light.

2  
Refraction known to the ancients.

3  
And the magnifying power of glass-globes.

4  
Refraction first treated of by Ptolemy.

5  
His hypothesis concerning the horizontal sun and moon.

fraction of the rays by vapours, which actually enlarge the angle under which the luminaries appear; just as the angle is enlarged by which an object is seen from under water.

6  
Discoveries  
of Alhazen.

In the 12th century, the nature of refraction was largely considered by Alhazen an Arabian writer; in so much that, having made experiments upon it at the common surface between air and water, air and glass, water and glass or crystal; and, being prepossessed with the ancient opinion of crystalline orbs in the regions above the atmosphere, he even suspected a refraction there also, and fancied he could prove it by astronomical observations. This author deduces from hence several properties of atmospherical refraction, as that it increases the altitudes of all objects in the heavens; and he first advanced, that the stars are sometimes seen above the horizon by means of refraction, when they are really below it. This observation was confirmed by Vitellio, B. Waltherus, and especially by the excellent observations of Tycho Brahe. Alhazen observed, that refraction contracts the diameters and distances of the heavenly bodies, and that it is the cause of the twinkling of the stars. But we do not find that either he, or his follower Vitellio, knew any thing of its just quantity. Indeed it is too small to be determined except by very accurate instruments, and therefore we hear little more of it till about the year 1500; at which time great attention was paid to it by Bernard Walther, Maestlin, and others, but chiefly by Tycho Brahe.

Alhazen supposed that the refraction of the atmosphere did not depend upon the vapours in it, as was probably the opinion of philosophers before his time, but on the different transparency; by which, as Montucla conjectures, he meant the density of the gross air contiguous to the earth, and the ether or subtle air that lies beyond it. In examining the effects of refraction, he endeavours to prove that it is so far from being the cause of the heavenly bodies appearing larger near the horizon, that it would make them appear less; two stars, he says, appearing nearer together in the horizon, than near the meridian. This phenomenon he ranks among optical deceptions. We judge of distance, he says, by comparing the angle under which objects appear, with their supposed distance; so that if these angles be nearly equal, and the distance of one object be conceived greater than that of the other, it will be imagined to be larger. And the sky near the horizon he says is always imagined to be further from us than any other part of the concave surface. Roger Bacon ascribes this account of the horizontal moon to Ptolemy; and as such it is examined, and objected to by B. Porta.

In the writings of this philosopher we find the first distinct account of the magnifying power of glasses; and it is not improbable, that what he wrote upon this subject gave rise to that most useful invention of spectacles. For he says, that if an object be applied close to the base of the larger segment of a sphere of glass, it will appear magnified. He also treats of the appearance of an object through a globe, and says that he was the first who observed the refraction of rays into it.

7  
Of Vitellio.

In 1270, Vitellio, a native of Poland, published a treatise of optics, containing all that was valuable in Alhazen, and digested in a much more intelligible and

methodical manner. He observes, that light is always lost by refraction, in consequence of which the objects seen by refracted light always appear less luminous; but he does not pretend to estimate the quantity of this loss. He reduced into a table the result of his experiments on the refractive powers of air, water, and glass, corresponding to different angles of incidence. In his account of the horizontal moon he agrees exactly with Alhazen; observing, that in the horizon she seems to touch the earth, and appears much more distant from us than in the zenith, on account of the intermediate space containing a greater variety of objects upon the visible surface of the earth. He ascribes the twinkling of the stars to the motion of the air in which the light is refracted; and to illustrate this hypothesis, he observes, that they twinkle still more when viewed in water put in motion. He also shews, that refraction is necessary as well as reflection, to form the rainbow; because the body which the rays fall upon is a transparent substance, at the surface of which one part of the light is always reflected and another refracted. But he seems to consider refraction as serving only to condense the light, and thereby enabling it to make a stronger impression upon the eye. This writer also makes some ingenious attempts to explain refraction, or to ascertain the law of it. He also considers the foci of glass spheres, and the apparent size of objects seen through them; though upon these subjects he is not at all exact. It is sufficient indeed to shew the state of knowledge, or rather of ignorance, at that time, to observe, that both Vitellio, and his master Alhazen, endeavour to account for objects appearing larger when they are seen under water by the circular figure of its surface; since, being fluid, it conforms to the figure of the earth.

Cotemporary with Vitellio was Roger Bacon, a man <sup>8</sup> Of Roger Bacon. of very extensive genius, and who wrote upon almost every branch of science; yet he does not seem to have made any considerable advances beyond what Alhazen had done before him. Even some of the wildest and most absurd of the opinions of the ancients have had the sanction of his authority. He does not hesitate to assent to an opinion adopted by many of the ancients, and indeed by most philosophers till his time, that visual rays proceed from the eye; giving this reason for it, that every thing in nature is qualified to discharge its proper functions by its own powers, in the same manner as the sun and other celestial bodies. In his *Specula Mathematica*, he added some observations on the refraction of the light of the stars; the apparent size of objects; the extraordinary size of the sun and moon in the horizon: but in all this he is not very exact, and advances but little. In his *Opus Majus* he demonstrates, that if a transparent body interposed between the eye and an object, be convex towards the eye, the object will appear magnified. This observation, however, he certainly had from Alhazen; the only difference between them is, that Bacon prefers the smaller segment of a sphere, and Alhazen the larger, in which the latter certainly was right.

From this time, to that of the revival of learning in <sup>9</sup> Of Maurolycus. Europe, we have no farther treatise on the subject of optics. One of the first who distinguished himself in this way was, Maurolycus teacher of mathematics at Messina. In a treatise

treafie, *De Lumine et Umbrâ*, published in 1575, he demonstrates that the crystalline humour of the eye is a lens that collects the rays of light issuing from the objects, and throws them upon the retina where is the focus of each pencil. From this principle he discovered the reason why some people were short-sighted and others long-sighted; and why the former are relieved by concave, and the others by convex, glasses.

<sup>10</sup> Discoveries of B. Porta. About the same time that Maurolycus made such advances towards the discovery of the nature of vision, Joannes Baptista Porta of Naples discovered the *camera obscura*, which throws fill more light on the same subject. His house was constantly resorted to by all the ingenious persons at Naples, whom he formed into what he called an *academy of secrets*; each member being obliged to contribute something that was not generally known, and might be useful. By this means he was furnished with materials for his *Magia Naturalis*, which contains his account of the *camera obscura*, and the first edition of which was published, as he informs us, when he was not quite 15 years old. He also gave the first hint of the magic lantern; which Kircher afterwards followed and improved. His experiments with the *camera obscura* convinced him, that vision is performed by the intromission of something into the eye, and not by visual rays proceeding from the eye as had been formerly imagined; and he was the first who fully satisfied himself and others upon this subject. Indeed the resemblance between experiments with the *camera obscura* and the manner in which vision is performed in the eye, was too striking to escape the observation of a less ingenious person. But when he says that the eye is a *camera obscura*, and the pupil the hole in the window-shutter, he was so far mistaken as to suppose that it was the crystalline humour that corresponds to the wall which receives the images; nor was it discovered till the year 1604, that this office is performed by the retina. He makes a variety of just observations concerning vision; and particularly explains several cases in which we imagine things to be without the eye, when the appearances are occasioned by some affection of the eye itself, or some motion within the eye. He observes also, that, in certain circumstances, vision will be assisted by convex or concave glasses; and he seems also to have made some small advances towards the discovery of telescopes. He takes notice, that a round and flat surface plunged into water, will appear hollow as well as magnified to an eye perpendicularly over it; and he very well explains by a figure, the manner in which it is done.

<sup>11</sup> The law of refraction discovered. All this time, however, the great problem concerning the measuring of refractions had remained unsolved. Alhazen and Vitellio, indeed, had attempted it; but failed, by attempting to measure the angle itself, instead of its sine. At last, however, it was discovered by Snellius, professor of mathematics at Leyden. This philosopher, however, did not perfectly understand his own discovery, nor did he live to publish any account of it himself. It was afterwards explained by professor Hortensius both publicly and privately, before it appeared in the writings of Descartes, who published it under a different form, without making any acknowledgement of his obligations to Snellius, whose papers Huygens assures us, from his own knowledge, Descartes had seen.

It does not appear that, before Descartes, any person attempted to explain the cause of refraction; which he undertook to do by the resolution of forces, on the principles of mechanics. In consequence of this, he was obliged to suppose that light passes with more ease through a dense medium, than through a rare one. The truth of this explanation was first questioned by M. Fermat, counsellor to the parliament of Thoulouse, and an able mathematician. He asserted, contrary to the opinion of Descartes, that light suffers more resistance in water than air, and more in glass than in water; and he maintained, that the resistance of different mediums with respect to light is in proportion to their densities. M. Leibnitz adopted the same general idea; and these gentlemen argued upon the subject in the following manner.

Nature, say they, accomplishes her ends by the shortest methods. Light therefore ought to pass from one point to another, either by the shortest road, or that in which the least time is required. But it is plain that the line in which light passes, when it falls obliquely upon a denser medium, is not the most direct or the shortest; so that it must be that in which the least time is spent. And whereas it is demonstrable, that light falling obliquely upon a denser medium (in order to take up the least time possible in passing from a point in one medium to a point in the other) must be refracted in such a manner, that the sines of the angles of incidence and refraction must be to one another, as the different facilities with which light is transmitted in those mediums; it follows, that since light approaches the perpendicular when it passes obliquely from air into water, so that the sine of the angle of refraction is less than that of the angle of incidence, the facility with which water suffers light to pass through it is less than that of the air; so that light meets with more resistance in water than air.

<sup>13</sup> Arguments of this kind could not give satisfaction; Discoveries and a little time shewed the fallacy of the hypothesis, concerning the refraction of light. At a meeting of the Royal Society, Aug. 31. 1664, an experiment for measuring the refraction of common water was made with a new instrument which they had prepared for that purpose; and, the angle of incidence being 40 degrees, that of refraction was found to be 30. About this time also we find the first mention of mediums not refracting the light in an exact proportion to their densities. For Mr Boyle, in a letter to Mr Oldenburgh, dated Nov. 3. 1664, observes, that in spirit-of-wine, the proportion of the sines of the angles of incidence to the sines of the angles of refraction was nearly the same, viz. as 4 to 3; and that, as spirit-of-wine occasions a greater refraction than common water, so oil of turpentine, which is lighter than spirit-of-wine, produces not only a greater refraction than common water, but a much greater than salt water. And at a meeting held Nov. 9. the same year, Dr Hooke (who had been ordered to prosecute the experiment) brought in an account of one that he had made with pure and clear salad oil, which was found to have produced a much greater refraction than any liquor which he had then tried; the angle of refraction that answered to an angle of incidence of 30° being found no less than 40° 30', and the angle of refraction that answered to an angle of incidence of 20° being 29° 47'.—M. de la Hire also made

made several experiments to ascertain the refractive power of oil with respect to that of water and air, and found the sine of the angle of incidence to that of refraction to be as 60 to 42; which, he observes, is a little nearer to that of glass than to that of water, though oil is much lighter than water, and glass much heavier.

The members of the Royal Society finding that the refraction of salt water exceeded that of fresh, pursued the experiment farther with solutions of vitriol, saltpetre, and alum, in water; when they found the refraction of the solution of vitriol and saltpetre a little more, but that of alum a little less, than common water.

Dr Hooke made an experiment before the Royal Society, Feb. 11. 1663, which clearly proves that ice refracts the light less than water; which he took to be a good argument that the lightness of ice, which causes it to swim in water, is not caused only by the small bubbles which are visible in it, but that it arises from the uniform constitution or general texture of the whole mass. M. de la Hire also took a good deal of pains to determine whether, as was then the common opinion, the refractive power of ice and water were the same; and he found, as Dr Hooke had done before, that ice refracts less than water.

By a most accurate and elaborate experiment made in the year 1698, in which a ray of light was transmitted through a Torricellian vacuum, Mr Lowthorp found, that the refractive power of air is to that of water as 36 to 34,400. He concludes his account of the experiment with observing, that the refractive power of bodies is not proportioned to the density, at least not to the gravity, of the refracting medium. For the refractive power of glass to that of water, is as 55 to 34, whereas its gravity is as 87 to 34; that is, the squares of their refractive powers are very nearly as their respective gravities. And there are some fluids, which, though they are lighter than water, yet have a greater power of refraction. Thus the refractive power of spirit-of-wine, according to Dr Hooke's experiment, is to that of water as 36 to 33, and its gravity reciprocally as 33 to 36, or 36½. But the refractive powers of air and water seem to observe the simple proportion of their gravities directly. And if this should be confirmed by succeeding experiments, it is probable, he says, that the refractive powers of the atmosphere are every-where, and at all heights above the earth, proportioned to its density and expansion: and then it would be no difficult matter to trace the light through it, so as to terminate the shadow of the earth; and, together with proper expedients for measuring the quantity of light illuminating an opaque body, to examine at what distances the moon must be from the earth to suffer eclipses of the observed durations.

Cassini the younger happened to be present when Mr Lowthorp made the abovementioned experiment before the Royal Society; and upon his return home, having made a report of it to the members of the Royal Academy of Sciences, those gentlemen endeavoured to repeat the experiment in 1700; but they did not succeed.—For, as they said, beams of light passed through the vacuum without suffering any refraction. The Royal society being informed of this,

were desirous that it might be put past dispute, by repeated and well-attested trials; and ordered Mr Haukibee to make an instrument for the purpose, by the direction of Dr Halley. It consisted of a strong brass prism, two sides of which had sockets to receive two plane glasses, whereby the air in the prism might either be exhausted or condensed. The prism had also a mercurial gage fixed to it, to discover the density of the contained air; and was contrived to turn upon its axis, in order to make the refractions equal on each side when it was fixed to the end of a telescope. The refracting angle was near 64°; and the length of the telescope was about 10 feet, having a fine hair in its focus. The event of this accurate experiment was as follows:

Having chosen a proper and very distinct erect object, whose distance was 2588 feet, June 15. O. S. 1708, in the morning, the barometer being then at 29. 7½, and the thermometer at 60, they first exhausted the prism, and then applying it to the telescope, the horizontal hair in the focus covered a mark on the object distinctly seen through the vacuum, the two glasses being equally inclined to the visual ray. Then admitting the air into the prism, the object was seen to rise above the hair gradually as the air entered, and in the end the hair was observed to hide a mark 10½ inches below the former mark. This they often repeated, and with the same success.

After this they applied the condensing engine to the prism; and having forced in another atmosphere, so that the density of the included air was double to that of the outward, they again placed it before the telescope, and, letting out the air, the object which before seemed to rise, appeared gradually to descend, and the hair at length rested on an object higher than before by the same interval of 10½ inches. This experiment they likewise frequently repeated, without any variation in the event.

They then forced in another atmosphere; and upon discharging the condensed air, the object was seen near 21 inches lower than before.

Now the radius in this case being 2588 feet, 10½ inches will subtend an angle of one minute and 8 seconds, and the angle of incidence of the visual ray being 32 degrees (because the angle of the glass planes was 64) it follows from the known laws of refraction, that as the sine of 39° is to that of 31°, 59', 26", differing from 32° by 34" the half of 1', 8"; so is the sine of any other incidence, to the sine of its angle of refraction; and so is radius, or 1000000, to 999736; which, therefore, is the proportion between the sine of incidence *in vacuo* and the sine of refraction from thence into common air.

It appears, by these experiments, that the refractive power of the air is proportionable to its density. <sup>16</sup>Refractive power of the air determined. And since the density of the atmosphere is as its weight directly, and its heat inversely, the ratio of its density, at any given time, may be had by comparing the heights of the barometer and thermometer; and thence he concludes that this will also be the ratio of the refraction of the air. But Dr Smith observes, that, before we can depend upon the accuracy of this conclusion, we ought to examine whether heat and cold alone may not alter the refractive power of air, while its density continues the same. This, he says, may



may be tried, by heating the condensed or rarified air, shut up in the prism, just before it is fixed to the telescope, and by observing whether the hair in its focus will continue to cover the same mark all the while that the air is cooling.

The French academicians, being informed of the result of the above-mentioned experiment, employed M. Delisle the younger; to repeat their former experiment with more care; and he presently found, that their operators had never made any vacuum at all, there being chinks in their instrument, through which the air had insinuated itself. He therefore annexed a gage to his instrument, by which means he was sure of his vacuum; and then the result of the experiment was the same with that in England. The refraction was always in proportion to the density of the air, excepting when the mercury was very low, and consequently the air very rare; in which case the whole quantity being very small, he could not perceive much difference in them. Comparing, however, the refractive power of the atmosphere, observed at Paris, with the result of his experiment, he found, that the best vacuum he could make was far short of that of the ethereal regions above the atmosphere.

Dr Hooke first suggested the thought of making allowance for the effect of the refraction of light, in passing from the higher and rarer, to the lower and denser regions of the atmosphere, in the computed height of mountains. To this he ascribes the different opinions of authors concerning the height of several very high hills. He could not account for the appearance of the Pike of Tenerif, and several very high mountains, at so great a distance as that at which they are actually seen, but upon the supposition of the curvature of the visual ray, that is made by its passing obliquely through a medium of such different density, from the top of them to the eye, very far distant in the horizon. All calculations of the height of mountains that are made upon the supposition that the rays of light come from the tops of them, to our eyes, in straight lines, must, he says, be very erroneous.

Dr Hooke gives a very good account of the twinkling of the stars; ascribing it to the irregular and unequal refraction of the rays of light, which is also the reason why the limbs of the sun, moon, and planets appear to wave or dance. And that there is such an unequal distribution of the parts of the atmosphere, he says, is manifest from the different degrees of heat and cold in the air. This, he says, will be evident by looking upon distant objects, over a piece of hot glass, which cannot be supposed to throw out any kind of exhalation from itself, as well as through ascending steams of water.

About this time Crimaldi first observed that the coloured image of the sun refracted through a prism is always oblong, and that colours proceed from refraction.—The way in which first he discovered this was by Vitellio's experiment above-mentioned, in which a piece of white paper placed at the bottom of a glass vessel filled with water, and exposed to the light of the sun, appears coloured. However, he observed, that in case the two surfaces of the refracting medium were exactly parallel to each other, no colours were produced. But of the true cause of those colours,

viz. the different refrangibility of the rays of light, he had not the least suspicion. This discovery was referred for Sir Isaac Newton, and which occurred to him in the year 1666. At that time he was busy in grinding optic glasses, and procured a triangular glass prism to satisfy himself concerning the phenomena of colours. While he amused himself with this, the oblong figure of the coloured spectrum first struck him. He was surpris'd at the great disproportion betwixt its length and breadth; the former being about five times the measure of the latter. He could hardly think that any difference in the thickness of the glass, or in the composition of it, could have such an influence on the light. However, without concluding any thing *à priori*, he proceeded to examine the effects of these circumstances, and particularly tried what would be the consequence of transmitting the light through parts of the glass that were of different thicknesses, or through holes in the window-shutter of different sizes; or by setting the prism on the outside of the shutter, that the light might pass through it, and be refracted before it was terminated by the hole.

He then suspected that these colours might arise from the light being dilated by some unevenness in the glass, or some other accidental irregularity; and to try this, he took another prism, like the former, and placed it in such a manner, as that the light, passing through them both, might be refracted contrary ways, and so to be returned by the latter into the same course from which he had been diverted by the former. In this manner he thought that the regular effects of the first prism would be destroyed by the second; but that the irregular ones would be augmented by the multiplicity of refractions. The event was, that the light, which by the first prism was diffused into an oblong form, was by the second reduced into a circular one, with as much regularity as if it had not passed through either of them.

At last, after various experiments and conjectures, he hit upon what he calls the *experimentum crucis*, and which completed this great discovery. He took two boards, and placed one of them close behind the prism at the window, so that the light might pass through a small hole made in it for the purpose, and fall on the other board, which he placed at the distance of about 12 feet; having first made a small hole in it also, for some of that incident light to pass through. He then placed another prism behind the second board, so that the light which was transmitted through both the boards might pass through that also, and be again refracted before it arrived at the wall. This being done, he took the first prism in his hand, and turned it about its axis, so much as to make the several parts of the image, cast on the second board, successively to pass through the hole in it, that he might observe to what places on the wall the second prism would refract them; and he saw, by the change of those places, that the light tending to that end of the image towards which the refraction of the first prism was made, did, in the second prism, suffer a refraction considerably greater than the light which tended to the other end. This true cause, therefore, of the length of that image was discovered to be no other, than that light is not similar, or homogeneal; but that

13  
Colours  
discovered  
to arise  
from refraction.

it consists of rays, some of which are more refrangible than others: so that, without any difference in their incidence on the same medium, some of them shall be more refracted than others; and therefore, that, according to their particular degrees of refrangibility, they will be transmitted through the prism to different parts of the opposite wall.

Since it appears from these experiments that different rays of light have different degrees of refrangibility, it necessarily follows, that the rules laid down by preceding philosophers concerning the refractive power of water, glass, &c. must be limited to the middle kind of rays. Sir Isaac, however, proves that the sine of the incidence of every kind of light, considered apart, is to its sine of refraction in a given ratio. This he deduces, both by experiment, and also geometrically, from the supposition that bodies refract the light by acting upon its rays in lines perpendicular to their surfaces.

17  
Mr Dollond's discovery of the method of correcting the faults in refracting telescopes.

The most important discovery with regard to refraction since the time of Sir Isaac Newton is that of Mr Dollond, who found out a method of curing the faults of refracting telescopes arising from the different refrangibility of the rays, and which had been generally thought impossible to be removed.—Notwithstanding the great discovery of Sir Isaac Newton concerning the different refrangibility of the rays of light, he had no idea but that they were all affected in the same proportion by every medium, so that the refrangibility of the extreme rays might be determined if that of the mean ones was given. From this it would follow, as Mr Dollond observes, that equal and contrary refractions must not only destroy each other, but that the divergency of the colours from one refraction would likewise be corrected by the other, and there could be no possibility of producing any such thing as refraction which would not be affected by the different refrangibility of light; or, in other words, that however a ray of light might be refracted backwards and forwards by different mediums, as water, glass, &c. provided it was so done, that the emergent ray should be parallel to the incident one, it would ever after be white; and consequently, if it should come out inclined to the incident, it would diverge, and ever after be coloured; and from this it was natural to infer, that all spherical object-glasses of telescopes must be equally affected by the different refrangibility of light, in proportion to their apertures, of whatever materials they may be formed.

For this reason, Sir Isaac Newton, and all other philosophers and opticians, had despaired of bringing refracting telescopes to any great degree of perfection, without making them of an immoderate and very inconvenient length. They therefore applied themselves chiefly to the improvement of the reflecting telescope; and the business of refraction was dropped till about the year 1747, when M. Euler, improving upon a hint of Sir Isaac Newton's, formed a scheme of making object-glasses of two materials, of different refractive powers; hoping, that by this difference, the refractions would balance one another, and thereby prevent the dispersion of the rays that is occasioned by the difference of refrangibility. These object-glasses were composed of two lenses of glass with water between them. This memoir of M. Euler excited the

attention of Mr Dollond. He carefully went over all M. Euler's calculations, substituting for his hypothetical laws of refraction, those which had been actually ascertained by the experiments of Newton; and found, that, after this necessary substitution, it followed from M. Euler's own principles, that there could be no union of the foci of all kinds of colours, but in a lens infinitely large.

M. Euler did not pretend to controvert the experiments of Newton: but he said, that they were not contrary to his hypothesis, but in so small a degree as might be neglected; and asserted, that, if they were admitted in all their extent, it would be impossible to correct the difference of refrangibility occasioned by the transmission of the rays from one medium into another of different density; a correction which he thought was very possible, since he supposed it to be actually effected in the structure of the eye, which he thought was made to consist of different mediums for that very purpose. To this kind of reasoning Mr Dollond made no reply, but by appealing to the experiments of Newton, and the great circumspection with which it was known that he conducted all his inquiries.

In this state of the controversy, the friends of M. Clairaut engaged him to attend to it; and it appeared to him, that, since the experiments of Newton cited by Mr Dollond could not be questioned, the speculations of M. Euler were more ingenious than useful.

The same paper of M. Euler was also particularly noticed by M. Klingenshierna of Sweden, who gave a considerable degree of attention to the subject, and discovered, that, from Newton's own principles, the result of the 8th experiment of the second book of his Optics could not answer his description of it.

He found, he says, that when light goes out of air through several contiguous refracting mediums, as through water and glass, and thence goes out again into air, whether the refracting surfaces be parallel or inclined to one another, that light, as often as by contrary refractions it is so corrected as to emerge in lines parallel to those in which it was incident, continues ever after to be white; but if the emergent rays be inclined to the incident, the whiteness of the emerging light will, by degrees, in passing on from the place of emergence, become tinged at its edges with colours. This he tried by refracting light with prisms of glass, placed within a prismatic vessel of water.

By theorems deduced from this experiment he infers, that the refractions of the rays of every sort, made out of any medium into air, are known by having the refraction of the rays of any one sort; and also that the refraction out of one medium into another is found as often as we have the refractions out of them both into any third medium.

On the contrary, the Swedish philosopher observes, that, in this experiment, the rays of light, after passing through the water and the glass, though they come out parallel to the incident rays, will be coloured; but that the smaller the glass prism is, the near will the result of it approach to Newton's description.

This paper of M. Klingenshierna, being communicated to Mr Dollond by M. Mallet, made him entertain

tain doubts concerning Newton's report, and determined him to have recourse to experiment.

He therefore cemented together two plates of parallel glass at their edges, so as to form a prismatic vessel, when stopped at the ends or bases; and the edge being turned downwards, he placed in it a glass prism, with one of its edges upwards, and filled up the vacancy with clear water; so that the refraction of the prism was contrived to be contrary to that of the water, in order that a ray of light, transmitted through both these refracting mediums, might be affected by the difference only between the two refractions. As he found the water to refract more or less than the glass prism, he diminished or increased the angle between the glass plates, till he found the two contrary refractions to be equal; which he discovered by viewing an object thro' this double prism. For when it appeared neither raised or depressed, he was satisfied that the refractions were equal, and that the emergent rays were parallel to the incident.

Now, according to the prevailing opinion, he observes, that the object should have appeared thro' this double prism in its natural colour; for if the difference of refrangibility had been in all respects equal in the two equal refractions, they would have rectified each other. But this experiment fully proved the fallacy of the received opinion, by shewing the divergency of the light by the glass prism, to be almost double of that by the water; for the image of the object, though not at all refracted, was yet as much inflected with prismatic colours, as if it had been seen thro' a glass wedge only, whose refracting angle was near 30 degrees.

This experiment is the very same with that of Sir Isaac Newton's above-mentioned, notwithstanding the result was so remarkably different: but Mr Dollond assures us, that he used all possible precaution and care in his process; and he kept his apparatus by him, that he might evince the truth of what he wrote, whenever he should be properly required to do it.

He plainly saw, however, that if the refracting angle of the water vessel could have admitted of a sufficient increase, the divergency of the coloured rays would have been greatly diminished, or entirely rectified; and that there would have been a very great refraction without colour, as he had already produced a great discolouring without refraction: but the inconvenience of so large an angle, as that of the prismatic vessel must have been, to bring the light to an equal divergency with that of the glass prism whose angle was about 60 degrees, made it necessary to try some experiments of the same kind with smaller angles.

Accordingly, he got a wedge of plate glass, the angle of which was only nine degrees; and using it in the same circumstances, he increased the angle of the water wedge, in which it was placed, till the divergency of the light by the water was equal to that by the glass; that is, till the image of the object, though considerably refracted by the excess of the refraction of the water, appeared nevertheless quite free from any colours proceeding from the different refrangibility of the light; and, as near as he could then measure, the refraction by the water was about  $\frac{1}{2}$  of that by the glass. He acknowledges, indeed, that he was not

very exact in taking these measures, because his business was not at that time to determine the exact proportions, so much as to shew that the divergency of the colours, by different substances, was by no means in proportion to the refractions, and that there was a possibility of refraction without any divergency of the light at all.

As these experiments clearly proved, that different substances made the light to diverge very differently in proportion to their general refractive power, Mr Dollond began to suspect that such variety might possibly be found in different kinds of glass, especially as experience had already shewn that some of the kinds made much better object-glasses in the usual way than others; and as no satisfactory cause had been assigned for such difference, he thought there was great reason to presume that it might be owing to the different divergency of the light in the same refractions.

His next business, therefore, was to grind wedges of different kinds of glass, and apply them together; so that the refractions might be made in contrary directions, in order to discover, as in the above-mentioned experiments, whether the refraction and the divergency of the colours would vanish together. But a considerable time elapsed before he could set about that work: for tho' he was determined to try it at his leisure, for satisfying his own curiosity, he did not expect to meet with a difference sufficient to give room for any great improvement of telescopes, so that it was not till the latter end of the year 1757 that he undertook it; but his first trials convinced him that the business deserved his utmost attention and application.

He discovered a difference far beyond his hopes in the refractive qualities of different kinds of glass, with respect to the divergency of colours. The yellow or straw-coloured foreign sort, commonly called *Venice glass*, and the *English crown glass*, proved to be very nearly alike in that respect; though, in general, the crown glass seemed to make the light diverge the less of the two. The common English plate-glass made the light diverge more; and the white crystal, or English flint-glass, most of all.

It was now his business to examine the particular qualities of every kind of glass that he could come at, not to amuse himself with conjectures about the cause of this difference, but to fix upon two sorts in which it should be the greatest; and he soon found these to be the crown glass, and the white flint glass. He therefore ground one wedge of white flint, of about 25 degrees; and another of crown glass, of about 29 degrees; which refracted very nearly alike, but their power of making the colours diverge was very different. He then ground several others of crown glass to different angles, till he got one which was equal, with respect to the divergency of the light, to that in the white flint-glass: for when they were put together, so as to refract in contrary directions, the refracted light was entirely free from colours. Then measuring the refraction of each wedge with these different angles, he found that of the white glass to be to that of the crown glass, nearly as two to three: and this proportion held very nearly in all small angles; so that any two wedges made in this proportion, and applied

plied together, so as to refract in a contrary direction, would refract the light without any dispersion of the rays.

In a letter to M. Klengenhierna, quoted by M. Clairaut, Mr Dollond says, that the sine of incidence in crown glass is to that of its general refraction as 1 to 1.53, and in flint glass as 1 to 1.583.

To apply this knowledge to practice, Mr Dollond went to work upon the object-glasses of telescopes; not doubting but that, upon the same principles on which a refracted colourless ray was produced by prisms, it might be done by lenses also, made of similar materials. And he succeeded, by considering, that in order to make two spherical glasses that should refract the light in contrary directions, the one must be concave and the other convex; and as the rays are to converge to a real focus, the excess of refraction must evidently be in the convex lens. Also, as the convex glass is to refract the most, it appeared from his experiments, that it must be made of crown glass, and the concave of white flint glass. Farther, as the refractions of spherical glasses are in an inverse ratio of their focal distances, it follows, that the focal distances of the two glasses shall be inversely as the ratios of the refractions of the wedges; for being thus proportioned, every ray of light that passes thro' this combined glass, at whatever distance it may pass from its axis, will constantly be refracted, by the difference between two contrary refractions, in the proportion required; and therefore the different refrangibility of the light will be entirely removed.

Notwithstanding our author had these clear grounds in theory and experiment to go upon, he found that he had many difficulties to struggle with when he came to reduce them into actual practice; but with great patience and address, he at length got into a ready method of making telescopes upon these new principles.

His principal difficulties arose from the following circumstances. In the first place, the focal distances, as well as the particular surfaces, must be very nicely proportioned to the densities or refracting powers of the glasses, which are very apt to vary in the same sort of glass made at different times. Secondly, The centres of the two glasses must be placed truly in the common axis of the telescope, otherwise the desired effect will be in a great measure destroyed. Add to these, that there are four surfaces to be wrought perfectly spherical; and any person, he says, but moderately practised in optical operations, will allow, that there must be the greatest accuracy throughout the whole work. At length, however, after numerous trials, and a resolute perseverance, he was able to construct refracting telescopes, with such apertures and magnifying powers, under limited lengths, as, in the opinion of the best judges, far exceeded any thing that had been produced before, representing objects with great distinctness, and in their true colours.

It was objected to Mr Dollond's discovery, that the small dispersion of the rays in crown glass is only apparent, owing to the opacity of that kind of glass which does not transmit the fainter coloured rays in a sufficient quantity; but this objection is particularly

considered, and answered by M. Beguelin.

As Mr Dollond did not explain the methods which he took in the choice of different spheres proper to destroy the effect of the different refrangibility of the rays of light, and gave no hint that he himself had any rule to direct himself in it; and as the calculation of the dispersion of the rays, in so complicated an affair, is very delicate; M. Clairaut, who had given a good deal of attention to this subject, from the beginning of the controversy, endeavoured to make out a complete theory of it.

Without some assistance of this kind, it is impossible, says this author, to construct telescopes of equal goodness with those of Mr Dollond, except by a fertile imitation of his; which, however, on many accounts, would be very unlikely to answer. Besides, Mr Dollond only gave his proportions in general, and pretty near the truth; whereas the greatest possible precision is necessary. Also the best of Mr Dollond's telescopes were far short of the Newtonian ones (A); whereas it might be expected that they should exceed them, if the foci of all the coloured rays could be as perfectly united after refraction thro' glass, as after reflexion from a mirror; since there is more light lost in the latter case than in the former.

With a view, therefore, to assist the artist, he endeavoured to ascertain the refractive power of different kinds of glass, and also their property of separating the rays of light, by the following exact methods. He made use of two prisms placed close to one another, as Mr Dollond had done; but, instead of looking thro' them, he placed them in a darkened room; and when the image of the sun, transmitted thro' them, was perfectly white, he concluded that the different refrangibility of the rays was corrected.

In order to ascertain with more ease the true angles that prisms ought to have to destroy the effect of the difference of refrangibility, he constructed one which had one of its surfaces cylindrical, with several degrees of amplitude. By this means, without changing his prisms, he had the choice of an infinity of angles; among which, by examining the point of the curve surface, which, receiving the solar ray, gave a white image, he could easily find the true one.

He also ascertained the proportion in which different kinds of glass separated the rays of light, by measuring, with proper precautions, the oblong image of the sun, made by transmitting a beam of light thro' them. In making these experiments, he hit upon an easy method of convincing any person of the greater refractive power of English flint-glass above the common French glass, both with respect to the mean refraction, and the different refrangibility of the colours; for having taken two prisms, of these two kinds of glass, but equal in all other respects, and placed them so that they received, at the same time, two rays of the sun, with the same degree of incidence, he saw, that, of the two images, that which was produced by the English flint-glass was a little higher upon the wall than the other, and longer by more than one half.

M. Clairaut was assisted in these experiments by M. De Tournieres, and the results agreed with Mr Dollond's

(A) This assertion of M. Clairaut might be true at the time that it was made, but it is by no means so at present.

lond's in general; but whereas Mr Dollond had made the dispersion of the rays in glass and in water to be as five to four (acknowledging, however, that he did not pretend to do it with exactness) these gentlemen, who took more pains, and used more precautions, found it to be as three to two. For the theorems and problems deduced by M. Clairaut from these new principles of optics, with a view to the perfection of telescopes, we must refer the reader to *Mem. Acad. Par. 1756, 1757*.

The labours of M. Clairaut were succeeded by those of M. D'Alembert, which seem to have given the makers of these achromatic telescopes all the aid that calculations can afford them. This excellent mathematician has likewise proposed a variety of new constructions of these telescopes, the advantages and disadvantages of which he distinctly notes; at the same time that he points out several methods of correcting the errors to which they are liable; as by placing the object-glasses, in some cases, at a small distance from one another, and sometimes by using eye-glasses of different refractive powers; which is an expedient that seems not to have occurred to any person before him. He even shews, that telescopes may be made to advantage, consisting of only one object-glass, and an eye-glass of a different refractive power. Some of his constructions have two or more eye-glasses of different kinds of glass. This subject he considered at large in one of the volumes of his *Opuscules Mathematiques*. We have also three memoirs of M. D'Alembert upon this subject, among those of the French Academy; one in the year 1764, another in 1765, and a third in 1767.

At the conclusion of his second memoir he says, that he does not doubt, but, by the different methods he proposes, achromatic telescopes may be made to far greater degrees of perfection than any that have been seen hitherto, and even such as is hardly credible: And tho' the crown glass, by its greenish colour, may absorb some part of the red or violet rays, which, however, is not found to be the case in fact; that objection cannot be made to the common French glass, which is white, and which on this account he thinks must be preferable to the English crown glass.

Notwithstanding Messrs Clairaut and D'Alembert seemed to have exhausted the business of calculation on the subject of Mr Dollond's telescopes, no use could be made of their labours by foreign artists. For still the telescopes made in England, according to no exact rule, as foreigners supposed, were greatly superior to any that could be made else where, though under the immediate direction of those able calculators. For this M. Bequelin assigned several reasons. Among others, he thought that their geometrical theorems were too general, and their calculations too complicated, for the use of workmen. He also thought, that in consequence of neglecting small quantities, which these calculators professedly did, in order to make their algebraical expressions more commodious, their conclusions were not sufficiently exact. But what he thought to be of the most consequence, was the want of an exact method of measuring the refractive and dispersing powers of the different kinds of glass; and for want of this, the greatest precision in calculation

was altogether useless.

These considerations induced this gentleman to take another view of this subject; but still he could not reconcile the actual effect of Mr Dollond's telescopes with his own conclusions: so that he imagined, either that he had not the true refraction and dispersion of the two kinds of glass given him; or else, that the aberration which still remained after his calculations, must have been destroyed by some irregularity in the surfaces of the lenses. He finds several errors in the calculations both of M. D'Alembert and Clairaut, and concludes with expressing his design to pursue this subject much farther.

M. Euler, who first gave occasion to this inquiry, which terminated so happily for the advancement of science, being persuaded both by his reasoning and calculations, that Mr Dollond had discovered no new principle in optics, and yet not being able to controvert Mr Short's testimony in favour of the goodness of his telescopes, concluded that this extraordinary effect was owing, in part, to the crown glass not transmitting all the red light, which would otherwise have come to a different focus, and have distorted the image; but principally to his happening to hit on a just curvature of his glass, which he did not doubt would have produced the same effect if his lenses had all been made of the same kind of glass. In another place he imagines that the goodness of Mr Dollond's telescope might be owing to the eye-glass. If my theory, says he, be true, this disagreeable consequence follows, that Mr Dollond's object-glasses cannot be exempt from the dispersion of colours: yet a regard to so respectable a testimony embarrassed me extremely, it being as difficult to question such express authority, as to abandon a theory which appears me perfectly well founded, and to embrace an opinion, which is as contrary to all the established laws of nature, as it is strange and seemingly absurd. He even appeals to experiments made in a darkened room; in which, he says, he is confident that Mr Dollond's object-glasses would appear to have the same defects that others are subject to.

No doubting, however, but that Mr Dollond, either by chance, or otherwise, had made some considerable improvement in the construction of telescopes, by the combination of glasses; he abandoned his former project, in which he had recourse to different mediums, and confined his attention to the correction of the errors which arise from the curvature of lenses. But while he was proceeding, as he imagined, upon the true principles of optics, of which, however, he made but little use, he could not help expressing his surprize that Mr Dollond should have been led to so important a discovery by reasoning in a manner quite contrary to the nature of things. At length, however, Mr Euler was convinced of the reality and importance of Mr Dollond's discoveries; and very frankly acknowledges, that he should, perhaps, never have brought to assent to it, had not his friend M. Clairaut assured him that the experiments of the English optician might be depended upon. However, the experiments of M. Zehner of Petersburg gave him the most complete satisfaction with respect to this new law of refraction.

This gentleman demonstrated, that it is the lead in the composition of glass that gives it this remarkable property,

property, that while the refraction of the mean rays is nearly the same, that of the extremes differs considerably. And, by increasing the quantity of lead in the mixture, he produced a kind of glass, which occasioned a much greater separation of the extreme rays than the flint-glass which Mr Dollond had made use of. By this evidence M. Euler owns that he was compelled to renounce the principle which, before this time, had been considered as incontrovertible, *viz.* that the dispersion of the extreme rays depends upon the refraction of the mean; and that the former varies with the quality of the glass, while the latter is not affected by it.

From these new principles M. Euler deduces theorems concerning the combination of the lenses, and, in a manner similar to M. Clairaut and D'Alembert, points out methods of constructing achromatic telescopes.

While he was employed upon this subject, he informs us, that he received a letter from M. Zeiler, dated Peterburgh 30th of January 1764, in which he gives him a particular account of the success of his experiments on the composition of glass; and that, having mixed minium and sand in different proportions, the result of the mean refraction and the dispersion of the rays varied according to the following table.

Proportion of minium to flint.	Mean refraction from air into glass.	Dispersion of the rays in comparison of crown-glass.
I. — 3 : 1	2028 : 1000	4800 : 1000
II. — 2 : 1	1830 : 1000	3550 : 1080
III. — 1 : 1	1787 : 1000	3259 : 1000
IV. — $\frac{1}{2}$ : 1	1732 : 1000	2207 : 1000
V. — $\frac{1}{3}$ : 1	1724 : 1000	1800 : 1000
VI. — $\frac{1}{4}$ : 1	1664 : 1000	1354 : 1000

By this table it is evident, that a greater quantity of lead not only occasions a greater dispersion of the rays, but also considerably increases the mean refraction. The first of these kinds of glass, which contains three times as much minium as flint, will appear very extraordinary; since, hitherto, no transparent substance has been known, whose refractive power exceeded the ratio of two to one, and that the dispersion occasioned by this glass is almost five times as great as that of crown glass, which could not be believed by those who entertained any doubt concerning the same property in flint glass, the effect of which is three times as great as crown glass. One may observe, however, in these kinds of glass, something of a proportion between the mean refraction and the dispersion of rays, which may enable us to reconcile these surprising effects with other principles already known.

Here, however, M. Euler announces to us another discovery of the same M. Zeiler, no less surprising than the former, and which disconcerted all his schemes for reconciling the above-mentioned phenomena. As the six kinds of glass mentioned in the above table were composed of nothing but minium and flint, M. Zeiler happened to think of mixing alkaline salts with them, in order to give the glass a consistence more proper for dioptric uses; when he was much surprised to find this mixture greatly diminished the mean refraction,

almost without making any change in the dispersion. After many trials, he at length obtained a kind of glass greatly superior to the flint-glass of Mr Dollond, with respect to the construction of telescopes; since it occasioned three times as great a dispersion of the rays as the common glass, at the same time that the mean refraction was only as 1.61 to 1.

M. Euler also gives particular instructions how to find both the mean and extreme refractive power of different kinds of glass; and particularly advises to make use of prisms with very large refracting angles, not less than 70°.

Notwithstanding it evidently appeared, we may say, to almost all philosophers, that Mr Dollond had made a real discovery of something not comprehended in the optical principles of Sir Isaac Newton, it did not appear so to Mr Murdoch. Upon this occasion, he interposed in the defence, as he imagined, of Sir Isaac Newton; maintaining, that Mr Dollond's positions, which, he says, he knows not by what mishap have been deemed paradoxes in Sir Isaac's theory of light, are really the necessary consequences of it. He also endeavours to shew that Sir Isaac might not be mistaken in his account of the experiment above-mentioned. But, admitting all that he advances in this part of his defence, Newton must have made use of a prism with a much smaller refracting angle than, from his own account of his experiments, we have any reason to believe that he ever did make use of.

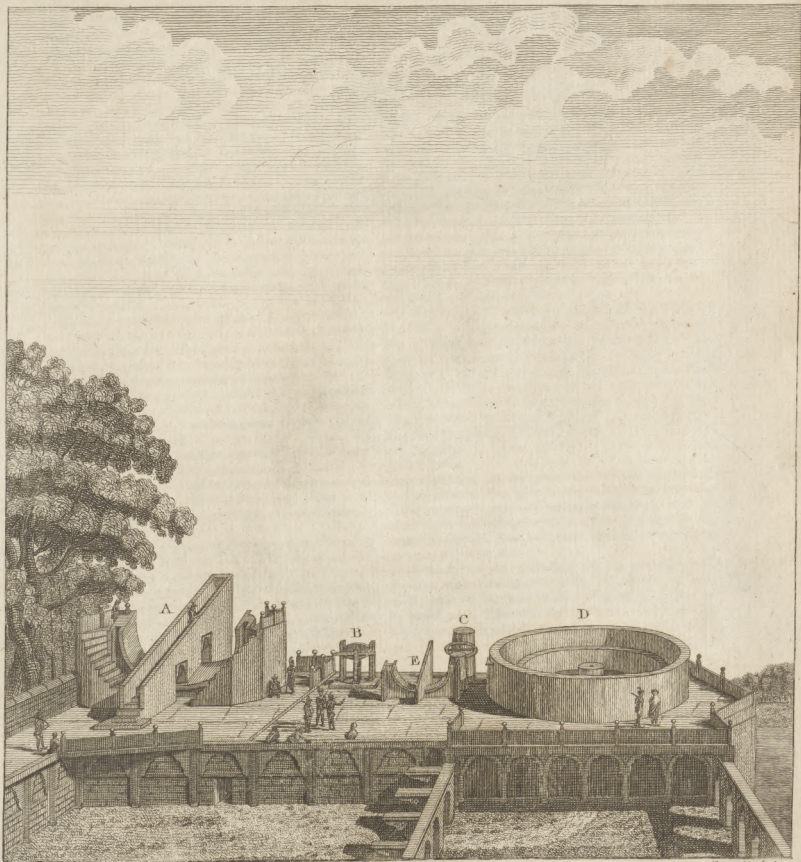
The fact probably was, that Sir Isaac deceived himself in this case, by attending to what he imagined to be the clear consequence of his other experiments; and though the light he saw was certainly tinged with colours, and he must have seen it to be so, yet he might imagine that this circumstance arose from some imperfection in his prisms, or in the disposition of them, which he did not think it worth his while to examine. It is also observable, that Sir Isaac is not so particular in his description of his prisms, and other parts of his apparatus, in his account of this experiment, as he generally is in other cases; and therefore, probably, wrote his account of it from his memory only. In reality, it is no reflection upon Sir Isaac Newton, who did so much, to say that he was mistaken in this particular case, and that he did not make the discovery that Mr Dollond did; though it be great praise to Mr Dollond, and all those persons who contributed to this discovery, that they ventured to call in question the authority of so great a man.

We shall conclude the history of the discoveries concerning refraction, with some account of the refractions of the atmosphere.—Tables of this have been calculated by Mr Lambert with a view to correct the inaccuracies of geometrical observations of the altitudes of mountains. The observations of Mr Lambert, however, go upon the supposition that the refractive power of the atmosphere is invariable: But this is by no means the case; and therefore his rules must be considered as true for the mean state of the air only.

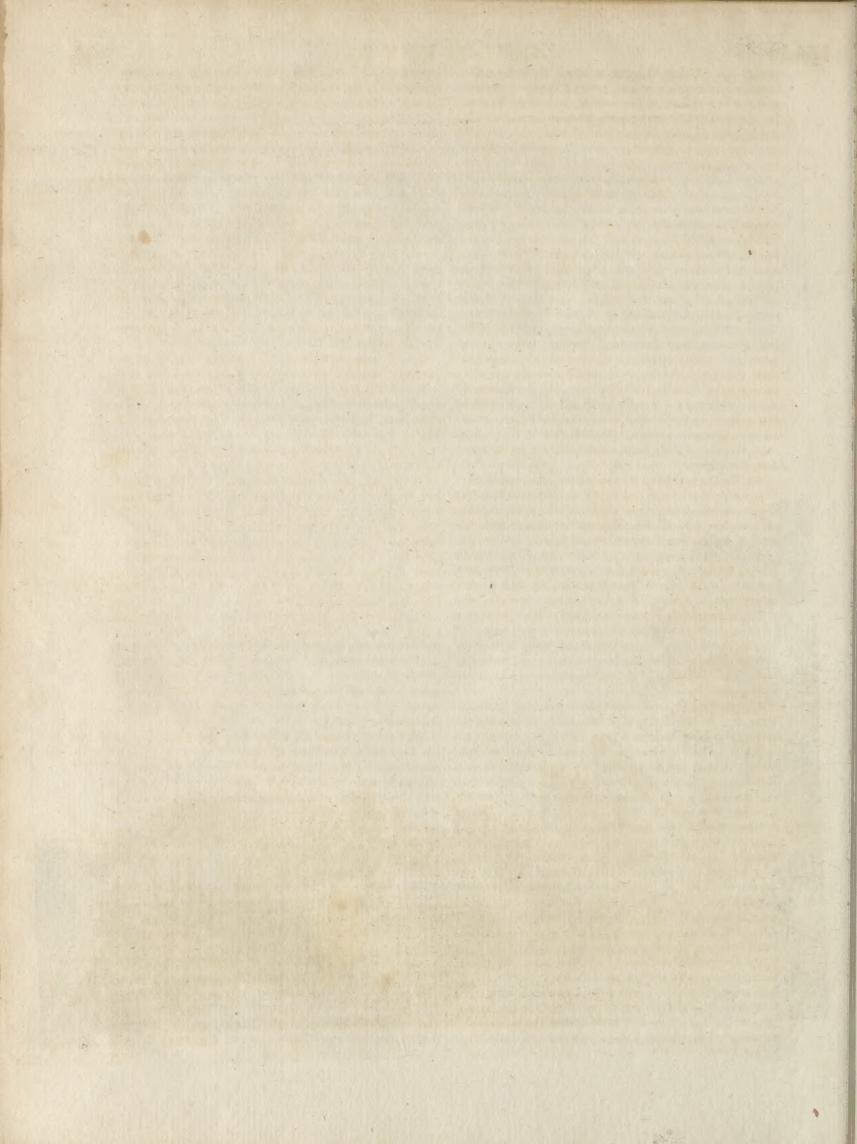
A most remarkable variety in the refractive power of the atmosphere was observed by Dr Nettleton, near Halifax in Yorkshire, which demonstrates how little we can depend upon the calculated heights of mountains, when the observations are made with an instrument, and the refractive power of the air is to be allowed

18  
Different compositions of glass for the purpose of correcting the faults of refracting telescopes.

19  
Of the refraction of the atmosphere.



A Bell Sculp<sup>to</sup>





lowed for. Being desirous to learn, by observation, how far the mercury would descend in the barometer at any given elevation, (for which there is the best opportunity in that hilly country), he proposed to take the height of some of their highest hills; but when he attempted it, he found his observation so much disturbed by refraction, that he could come to no certainty. Having measured one hill of a considerable height, in a clear day, and observed the mercury at the bottom and at the top, he found, according to that estimation, that about 90 feet, or more, were required to make the mercury fall  $\frac{1}{2}$  of an inch; but afterwards, repeating the experiment on a cloudy day, when the air was rather gross and lazy, he found the small angles so much increased by refraction as to make the hill much higher than before. He afterwards frequently made observations at his own house, by pointing a quadrant to the tops of some neighbouring hills, and observed that they would appear higher in the morning before sun-rise, and also late in the evening, than at noon in a clear day, by several minutes. In one case the elevations of the same hill differed more than 30 minutes. From this he infers, that observations made on very high hills, especially when viewed at a distance, and under small angles, as they generally are, are probably uncertain, and not much to be depended upon.

M. Euler considered with great accuracy the refractive power of the atmosphere, as affected by different degrees of heat and elasticity, in which he shews, that its refractive power, to a considerable distance from the zenith, is sufficiently near the proportion of the tangent of that distance, and that the law of refraction follows the direct ratio of the height of the barometer, and the inverse ratio of the difference marked by the thermometer; but when stars are in the horizon, the changes are in a ratio somewhat greater than this, more especially on account of the variation in the heat.

20  
Mr Michell's opinion concerning the twinkling of the stars.

The cause of the twinkling of the stars is now generally acknowledged to be the unequal refraction of light, in consequence of inequalities and undulations in the atmosphere.

Mr Michell supposes that the arrival of fewer or more rays at one time, especially from the smaller or the more remote fixed stars, may make such an unequal impression upon the eye, as may, at least, have some share in producing this effect; since it may be supposed, that even a single particle of light is sufficient to make a sensible impression upon the organs of sight; so that very few particles arriving at the eye in a second of time, perhaps no more than three or four, may be sufficient to make an object constantly visible. For though the impression may be considered as momentary, yet the perception occasioned by it is of some duration. Hence, he says, it is not improbable that the number of the particles of light which enter the eye in a second of time, even from Sirius himself, (the light of which does not exceed that of the smallest visible fixed star, in a greater proportion than that of about 1000 to 1), may not exceed 3000 or 4000, and from stars of the second magnitude they may, therefore, probably not exceed 100. Now the apparent increase and diminution of the light which we observe in the twinkling of the stars, seems to be repeated at not very unequal intervals, perhaps about four or five times in a

second. He therefore thought it reasonable to suppose, that the inequalities which will naturally arise from the chance of the rays coming sometimes a little denser, and sometimes a little rarer, in so small a number of them, as must fall upon the eye in the fourth or fifth part of a second, may be sufficient to account for this appearance. An addition of two or three particles of light, or perhaps a single one, upon 20, especially if there should be an equal deficiency out of the next 20, would, he supposed, be very sensible, as he thought was probable from the very great difference in the appearance of stars, the light of which does not differ so much as is commonly imagined. The light of the middlemost star in the tail of the great bear does not, he thinks, exceed the light of the very small star that is next to it in a greater proportion than that of about 16 or 20 to 1; and M. Bouguer found, that a difference in the light of objects of one part in 66 was sufficiently distinguishable.

It will perhaps, he says, be objected, that the rays coming from Sirius are too numerous to admit of a sufficient inequality arising from the common effect of chance, so frequently as would be necessary to produce this effect, whatever might happen with respect to the smaller stars; but he observes, that, till we know what inequality is necessary to produce this effect, we can only guess at it one way or the other.

Since these observations were published, Mr Michell has entertained some suspicion that the unequal density of light does not contribute to this effect in so great a degree as he had imagined, especially in consequence of observing that even Venus does sometimes twinkle. This he once observed her to do remarkably when she was about 6 degrees high, though Jupiter, which was then about 16 degrees high, and was sensibly less luminous, did not twinkle at all. If, notwithstanding the great number of rays which, no doubt, come to the eye from such a surface as this planet presents, its appearance be liable to be affected in this manner, it must be owing to such undulations in the atmosphere, as will probably render the effect of every other cause altogether insensible. The conjecture, however, has so much probability in it, that it well deserved to be recited.

M. Muschenbroek suspects, that the twinkling of the stars arises from some affection of the eye, as well as the state of the atmosphere. For he says, that in Holland, when the weather is frosty, and the sky very clear, the stars twinkle most manifestly to the naked eye, though not in telescopes; and since he does not suppose that there is any great exhalation, or dancing of the vapour at that time, he questions whether the vivacity of the light affecting the eye may not be concerned in the phenomenon.

But this philosopher might very easily have satisfied himself with respect to this hypothesis, by looking at the stars near the zenith, when the light traverses but a small part of the atmosphere, and therefore might be expected to affect the eye the most sensibly. For he would not have perceived them to twinkle near so much, as they do nearer the horizon, when much more of their light is intercepted by the atmosphere.

Some astronomers have lately endeavoured to explain the twinkling of the fixed stars by the extreme minuteness of their apparent diameter; so that

21.  
Mr Muschenbroek's opinion.

they suppose the light of them is intercepted by every mote that floats in the air. But Mr Michell observes, that no object can hide a star from us that is not large enough to exceed the apparent diameter of the star, by the diameter of the pupil of the eye; so that if a star was a mathematical point, the interposing object must fill be equal in size to the pupil of the eye: nay, it must be large enough to hide the star from both eyes at the same time.

Besides a variation in the quantity of light, a momentary change of colour has likewise been observed in some of the fixed stars. Mr Melville says, that when one looks steadfastly at Sirius, or any bright star not much elevated above the horizon, its colour seems not to be constantly white, but appears tinged, at every twinkling, with red and blue. This observation Mr Melville puts among his queries, with respect to which he could not entirely satisfy himself; and he observes, that the separation of the colours by the refractive power of the atmosphere is, probably, too small to be perceived. But the supposition of Mr Michell above-mentioned will pretty well account for this circumstance, though it may be thought inadequate to the former case. For the red and blue rays being much fewer than those of the intermediate colours, and therefore much more liable to inequalities, from the common effect of chance, a small excess or defect in either of them will make a very sensible difference in the colour of the stars.

### § 3. Discoveries concerning the Reflection of Light.

However much the ancients might have mistaken with regard to the nature of light, we find that they were acquainted with two very important observations concerning it; viz. that light is propagated in right lines, and that the angle of incidence is equal to the angle of reflection. Who it was that first made these important observations is not known. But indeed, important as they are, and the foundation of a great part of even the present system of optics, it is possible that, if he were known, he might not be allowed to have any share of merit, at least for the former of them; the fact is so very obvious, and so easily ascertained. As to the latter, that the angle of incidence is equal to the angle of reflection it was probably first discovered by observing a ray of the sun reflected from the surface of water, or some other polished body; or from observing the images of objects reflected by such surfaces. If philosophers attended to this phenomenon at all, they could not but take notice, that, if the ray fell nearly perpendicular upon such a surface, it was reflected near the perpendicular; and if it fell obliquely, it was reflected obliquely: and if they thought of applying any kind of measures to these angles, however coarse and imperfect, they could not but see that there was sufficient reason to assert their equality. At the same time they could not but know that the incident and reflected rays were both in the same plane.

Aristotle was sensible that it is the reflection of light from the atmosphere which prevents total darkness after the sun sets, and in places where he doth not shine in the day-time. He was also of opinion, that rainbows, halos, and mock suns, were all occasioned by the reflection of the sunbeams in different circum-

stances, by which an imperfect image of his body was produced, the colour only being exhibited, and not his proper figure. The image, he says, is not single, as in a mirror; for each drop of rain is too small to reflect a visible image, but the conjunction of all the images is visible.

Without inquiring any farther into the nature of light or vision, the ancient geometers contented themselves with deducing a system of optics from the two observations mentioned above, viz. the rectilinear progress of light, and the equality of the angles of incidence and reflection. The treatise of optics which has been ascribed to Euclid is employed about determining the apparent size and figure of objects, from the angle under which they appear, or which the extremities of them subtend at the eye, and apparent place of the image of an object reflected from a polished mirror; which he fixes at the place where the reflected ray meets a perpendicular to the mirror drawn through the object. But this work is so imperfect, and so inaccurately drawn up, that it is not generally thought to be the production of that great geometer.

It appears from a circumstance in the history of the Socrates, that the effects of burning-glasses had also been observed by the ancients; and it is probable that the Romans had a method of lighting their sacred fire by means of a concave speculum. It seems indeed to have been known pretty early, that there is an increase of heat in the place where the rays of light meet, when they are reflected from a concave mirror. The burning power of concave mirrors is taken notice of by Euclid in the second book of the treatise above-mentioned. If we give but a small degree of credit to what some ancient historians are said to have written concerning the exploits of Archimedes, we shall be induced to think that he made great use of this principle, in constructing some very powerful burning-mirrors; but nothing being said of other persons making use of his inventions, the whole account is very doubtful. It is allowed, however, that this eminent geometer did write a treatise on the subject of burning-mirrors, though it be not now extant.

B. Porta supposes that the burning-mirrors of the ancients were of metal, in the form of a section of a parabola. It follows from the properties of this curve, that all the rays which fall upon it, parallel to its axis, will meet in the same point at the focus. Consequently, if the vertex of the parabola be cut off, as in fig. 1. it will make a convenient burning-mirror. In some drawings of this instrument fruitum is so small, as to look like a ring. With an instrument of this kind, it is thought, that the Romans lighted their sacred fire. Some have also thought that this was the form of the mirror with which Archimedes burnt the Roman fleet; using either a lens, to throw the rays parallel, when they had been brought to a focus; or applying a smaller parabolic mirror for this purpose, as is represented fig. 2. But Dechaes shows, that it is impossible to convey any rays in a direction parallel to one another, except those that come from the same point in the sun's disk.

All this time, however, the nature of reflection was very far from being understood. Even lord Bacon,

who

<sup>22</sup>  
Account of the discoveries of the ancients.

<sup>23</sup>  
of Euclid's treatise of optics.

<sup>24</sup>  
Of the burning-glasses of the ancients.

<sup>25</sup>  
Of seeing images in the air.

who made much greater advances in natural philosophy than his predecessors, and who pointed out the true method of improving it, was so far deceived with regard to the nature of reflection and refraction, that he supposed it possible to see the image reflected from a looking-glass, without seeing the glass itself; and to this purpose he quotes a story of friar Bacon, who is reported to have apparently walked in the air between two steeples, and which was thought to have been effected by reflection from glasses while he walked upon the ground.

The whole business of seeing images in the air may be traced up to Vitellio; and what he said upon the subject seems to have passed from writer to writer, with considerable additions, to the time of lord Bacon. What Vitellio endeavours to shew is, that it is possible, by means of a cylindrical convex speculum, to see the images of objects in the air, out of the speculum, when the objects themselves cannot be seen. But, if his description of the apparatus requisite for this experiment be attended to, it will be seen that the eye was to be directed towards the speculum, which was placed within a room, while both the object and the spectator were without it. But though he recommends this observation to the diligent study of his readers, he has not described it in such a manner as is very intelligible; and, indeed, it is certain, that no such effect can be produced by a convex mirror. If he himself did make any trial with the apparatus that he describes for this purpose, he must have been under some deception with respect to it.

B. Porta says, that this effect may be produced by a plane mirror only; and that an ingenious person may succeed in it: but his more particular description of a method to produce this extraordinary appearance is by a plane mirror and a concave one combined.

Kircher also speaks of the possibility of exhibiting these pendulous images, and supposes that they are reflected from the dense air; and the most perfect and pleasing deception depending upon the images in the air is one of which this writer gives a particular account in his *Arts Magna Lucis et Umbrae*, p. 783. In this case the image is placed at the bottom of a hollow polished cylinder, by which means it appears like a real solid substance, suspended within the mouth of the vessel. In this manner, he says, he once exhibited a representation of the ascension of Christ; when the images were so perfect, that the spectators could not be persuaded, but by attempting to handle them, that they were not real substances.

Among other amusing things that were either invented or improved by Kircher, was the method of throwing the appearance of letters, and other forms of things, into a darkened room from without, by means of a lens and a plane mirror. The figures or letters were written upon the face of the mirror, and inverted; and the focus of the lens was contrived to fall upon the screen or wall that received their images. In this manner, he says, that with the light of the sun he could throw a plain and distinct image 500 feet.

It was Kepler who first discovered the true reason of the apparent places of objects seen by reflecting mirrors, as it depends upon the angle which the rays of light, issuing from the extreme part of an object, make with one another after such reflections. In place

mirrors these rays are reflected with the same degree of inclination to one another that they had before their incidence; but he shews that this inclination is changed in convex and concave mirrors.

Mr Boyle made some curious observations concerning the reflecting powers of differently coloured substances. Many learned men, he says, imagined that snow affects the eyes, not by a borrowed, but by a native light; but having placed a quantity of snow in a room from which all foreign light was excluded, neither he nor any body else was able to perceive it. To try whether white bodies reflect more light than others, he held a sheet of white paper in a sun-beam admitted into a darkened room; and observed that it reflected much more light than a paper of any other colour, a considerable part of the room being enlightened by it. Farther, to shew that white bodies reflect the rays outwards, he adds, that common burning-glasses will not of a long time burn or discolor white paper. When he was a boy, he says, and took great pleasure in making experiments with these glasses, he was much surprised at this remarkable circumstance; and it set him very early upon guessing at the nature of whiteness, especially as he observed that the image of the sun was not so well defined upon white paper as upon black; and as, when he put ink upon the paper, the moisture would be quickly dried up, and the paper, which he could not burn before, would presently take fire. He also found, that, by exposing his hand to the sun, with a thin black glove upon it, it would be suddenly and more considerably heated, than if he held his naked hand to the rays, or put on a glove of thin white leather.

To prove that black is the reverse of white, with respect to its property of reflecting the rays of the sun, he procured a large piece of black marble; and having got it ground into the form of a large spherical concave speculum, he found that the image of the sun reflected from it was far from offending or dazzling his eyes, as it would have done from another speculum; and tho' this was large, he could not in a long time set a piece of wood on fire with it; tho' a far less speculum, of the same form, and of a more reflecting substance, would presently have made it flame.

To satisfy himself still farther with respect to this subject, he took a broad and large tile; and having made one half of its surface white and the other black, he exposed it to the summer sun. And having let it lie there some time, he found, that while the white part remained cool, the part that was black was grown very hot. For his farther satisfaction, he sometimes left part of the tile of its native red; and, after exposing the whole to the sun, observed that this part grew hotter than the white, but was not so hot as the black part. He also observes, that rooms hung with black are not only darker than they would otherwise be, but warmer too; and he knew several persons, who found great inconvenience from rooms hung with black. As another proof of his hypothesis, he informs, that a virtuous, of unsuspected credit, acquainting him, that, in a hot climate, he had seen eggs well roasted in a short time, by first blacking the shells, and then exposing them to the sun.

We have already taken notice of the remarkable property of lignum nephriticum first observed by Kircher.

cher. However, all his observations with regard to it fell very short of Mr Boyle. He describes this lignum nephriticum to be a whitish kind of wood, that was brought from Mexico, which the natives call *coatl* or *tlapazatl*, and which had been thought to tinge water of a green colour only; but he says that he found it to communicate all kinds of colours. If, says he, an infusion of this wood be put into a glass globe, and exposed to a strong light, it will be as colourless as pure water; but if it be carried into a place a little shaded, it will be a most beautiful green. In a place still more shaded, it will incline to red; and in a very shady place, or in an opaque vessel, it will be green again.

A cup of this remarkable wood was sent to Kircher by the procurator of his society at Mexico, and was presented by him to the emperor as a great curiosity. It is called *lignum nephriticum*, because the infusion of it was imagined to be of service in diseases of the kidneys and bladder, and the natives of the country where it grows do make use of it for that purpose.

Mr Boyle corrected several of the hasty observations of Kircher concerning the colours that appear in the infusion of lignum nephriticum, and he diversified the experiments with it in a very pleasing manner. He first distinctly noted the two very different colours which this remarkable tincture exhibits, by transmitted and reflected light. If, says he, it be held directly between the light and the eye, it will appear tinged (excepting the very top of it, where a sky-coloured circle sometimes appears) almost of a golden colour, except the infusion be too strong; in which case it will be dark or reddish, and requires to be diluted with water. But if it be held from the light, so that the eye be between the light and the phial, it will appear of a deep lovely blue colour; as will also the drops, if any lie on the outside of the glass.

When a little of this tincture was poured upon a sheet of white paper, and placed in a window where the sun could shine upon it, he observed, that if he turned his back upon the sun, the shadow of his pen, or any such slender substance, projected upon the liquor, would not be all dark, like other shadows; but that part of it would be curiously coloured, the edge of it next the body being almost of a lively golden colour, and the more remote part blue. These, and other experiments of a similar nature, many of his friends, he says, beheld with wonder; and he remembered an excellent oculist, who accidentally meeting with a phial full of this liquor, and being unacquainted with this remarkable property of it, imagined, after he had viewed it a long time, that some new and strange dilemma had seized his eyes; and Mr Boyle himself acknowledges, that the oddness of the phenomenon made him very desirous to find out the cause of it; and his inquiries were not altogether unsuccessful.

Observing that this tincture, if it were too deep, was not tinged in so beautiful a manner, and that the impregnating virtue of the wood did, by being frequently infused in fresh water, gradually decay, he conjectured that the tincture contained much of the essential salt of the wood; and to try whether the subtle parts, on which the colour depended, were volatile enough to be distilled, without dissolving their

texture, he applied some of it to the gentle heat of a lamp-furnace; but he found all that came over was as limpid and colourless as rock water, while that which remained behind was of so deep a blue, that it was only in a very strong light that it appeared of any colour.

Suspecting that the tinging particles abounded with salts, whose texture, and the colour thence arising, would probably be altered by acids, he poured into a small quantity of it a very little spirit of vinegar, and found that the blue colour immediately vanished, while the golden one remained, on which ever side it was viewed with respect to the light.

Upon this he imagined, that as the acid salts of the vinegar had been able to deprive the liquor of its blue colour, a sulphureous salt, which is of a contrary nature, would destroy their effects; and having placed himself betwixt the window and the phial, and let fall into the same liquor a few drops of oil of tartar *per deliquium*, he found that it was immediately restored to its former blue colour, and exhibited all the same phenomena which it had done at the first.

Having sometimes brought a round long-necked phial, filled with this tincture, into a darkened room, into which a beam of the sun was admitted by a small aperture; and holding the phial sometimes near the sun-beams, and sometimes partly in them and partly out of them, changing also the position of the glass, and viewing it from several parts of the room, it exhibited a much greater variety of colours than it did in an enlightened room. Besides the usual colours, it was red in some places, and green in others, and within were intermediate colours produced by the different degrees and odd mixtures of light and shade.

It was not only in this tincture of lignum nephriticum that Mr Boyle observed the difference between reflected and transmitted light. He observed it even in gold, tho' no person explained the cause of these effects before Sir Isaac Newton. He took a piece of leaf-gold, and holding it betwixt his eye and the light, observed that it did not appear of a golden colour, but of a greenish blue. He also observed the same change of colour by candle-light; but the experiment did not succeed with a leaf of silver.

The constitution of the atmosphere and of the sea, we shall find, by observations made in later periods, to be similar to that of this infusion; for the blue rays, and others of a faint colour, do not penetrate so far into them as the red, and others of a stronger colour: but what this constitution is, which is common to them all, deserves to be inquired into. For almost all other tinctures, and this of lignum nephriticum too, after some change made in it by Mr Boyle, as well as all other semi-transparent coloured substances, as glasses, appear of the same hue in all positions of the eye. To increase or diminish the quantity makes no difference, but to make the colour deeper or more dilute.

The first distinct account of the colours exhibited by thin plates of various substances, are met with among the observations of Mr Boyle. To shew the thin chemists that colours may be made to appear or vanish, where there is no accession or change either of the sulphureous, the saline, or the mercurial principle of bodies, he observes, that all chemical essential oils,

as also good spirit of wine, being shaken till they rise in bubbles, appear of various colours; which immediately vanish when the bubbles burst, so that a colourless liquor may be immediately made to exhibit a variety of colours, and lose them in a moment, without any change in its essential principles. He then mentions the colours that appear in bubbles of soap and water, and also in turpentine. He sometimes got glass blown so thin as to exhibit similar colours; and observes, that a feather, of a proper shape and size, and also a black ribbon, held at a proper distance, between his eye and the sun, shewed a variety of little rainbows, as he calls them, with very vivid colours, none of which were constantly to be seen in the same objects.

<sup>30</sup>  
Dr Hooke's  
account of  
these co-  
lours.

Much more pains were taken with this subject, and a much greater number of observations respecting it were made, by Dr Hooke. As he loved to give surprise by his discoveries, he promised, at a meeting of the society on the 7th of March 1672, to exhibit, at their next meeting, something which had neither reflection nor refraction, and yet was diaphanous. Accordingly, at the time appointed, he produced the famous coloured bubble of soap and water, of which such admirable use was afterwards made by Sir Isaac Newton, but which Dr Hooke and his cotemporaries seem to have overlooked in Mr Boyle's treatise on colours, tho' it was published nine years before. It is no wonder that so curious an appearance excited the attention of that inquisitive body, and that they should desire him to bring an account of it in writing at their next meeting.

By the help of a small glass-pipe, there were blown several small bubbles, out of a mixture of soap and water; where it was observable, that, at first, they appeared white and clear; but that, after some time, the film of water growing thinner, there appeared upon it all the colours of the rainbow: First a pale yellow; then orange, red, purple, blue, green, &c. with the same series of colours repeated; in which it was farther observable, that the first and last series were very faint, and that the middlemost order or series was very bright. After these colours had passed over the changes above mentioned, the film of the bubble began to appear white again; and presently, in several parts of this second white film, there appeared several holes, which by degrees grew very big, several of them running into one another. After reciting other observations, which are not of much consequence, he says it is strange, that tho' both the encompassing and encompassed air have surfaces, yet he could not observe that they afforded either reflection or refraction, which all the other parts of the encompassed air did. This experiment, he says, at first sight, may appear very trivial, yet, as to the finding out the nature and cause of reflection, refraction, colours, congruity and incongruity, and several other properties of bodies, he looked upon it as one of the most instructive. And he promised to consider it more afterwards; but we do not find that ever he did; nor indeed is it to be much regretted, as we shall soon find this business in better hands. He adds, that that which gives one colour by reflection, gives another by trajection; not much unlike the tincture of lignum nephriticum.

Dr Hooke was the first to observe, if not to de-

scribe, the beautiful colours that appear in thin plates of muscovy glass. These, he says, are very beautiful to the naked eye, but much more when they are viewed with a microscope. With this instrument he could perceive that these colours were ranged in rings surrounding the white specks or flaws in this thin substance, that the order of the colours was the very same as in the rainbow, and that they were often repeated ten times. But the colours, he says, were disposed as in the outer bow, and not the inner. Some of them also were much brighter than others, and some of them very much broader. He also observed, that if there was a place where the colours were very broad, and conspicuous to the naked eye, they might be made, by pressing the place with the finger, to change places, and move from one part to another. Lastly, he observed, that if great care be used, this substance may be split into plates of  $\frac{1}{4}$  or  $\frac{1}{2}$  of an inch in diameter, each of which will appear thro' a microscope to be uniformly adorned with some one vivid colour, and that these plates will be found upon examination to be of the same thickness throughout.

As a fact similar to this, but observed previous to it, we shall here mention that Lord Brereton, at a meeting of the Royal Society in 1666, produced some pieces of glass taken out of a window of a church, both on the north and on the south side of it; observing, that they were all eaten in by the air, but that the piece taken from the south side had some colours like those of the rainbow upon it, which the others on the north side had not. This phenomenon has been frequently observed since, and in other circumstances. It is not to be doubted, but that in all these cases, the glass is divided into thin plates, which exhibit colours, upon the same principle with those which Dr Hooke observed in the bubble of soap and water, and in the thin plate of air, which we shall find more fully explained by Sir Isaac Newton. With care the thin plates of the glass may be separated, and the theory verified.

An observation made by Otto Guericke, well explains the reason why stars are visible at the bottom of a deep well. It is, says he, because the light that proceeds from them is not overpowered by the rays of the sun, which are lost in the number of reflections which they must undergo in the pit, so that they can never reach the eye of a spectator at the bottom of it.

<sup>31</sup>  
The  
stars are vi-  
sible by day  
at the bot-  
tom of a  
well.

But of all those who have given their attention to this subject of the reflection of light, none seems to have given such satisfaction as M. Bouguer, and next to those of Sir Isaac Newton, his labours seem to have been the most successful. The object of his curious and elaborate experiments was to measure the degrees of light, whether emitted, reflected, or refracted, by different bodies. They were originally occasioned by an article of M. Mairan's in the Memoirs of the French academy for 1721, in which the proportion of the light of the sun at the two solstices were supposed to be known, and his laudable attempt to verify what had been before taken for granted, suggested a variety of new experiments, and opened to him and to the world a new field of optical knowledge. His first production upon this subject was a treatise intitled *Essai d'Optique*, which was received with general approbation. After-

wards,

wards, giving more attention to this subject, he formed an idea of a much larger work, to which many more experiments were necessary: but he was prevented, by a variety of interruptions, from executing his design so soon as he had proposed; and he had hardly completed it at the time of his death, in 1758; so that we are obliged to his friend M. de la Caille for the care of the publication. At length, however, it was printed at Paris, in 1760, under the title of *Traite d'Optique*.

<sup>32</sup>  
Discoveries  
of M. Bou-  
guer.

At the entrance upon this treatise, we are induced to form the most pleasing expectations from our author's experiments, by his account of the variety, the singular accuracy, and circumspection, with which he made them; whereby he must, to all appearance, have guarded against every avenue to error, and particularly against those objections to which the few attempts that had been made, of a similar nature, before him had been liable. In order to compare different degrees of light, he always contrived to place the bodies from which it proceeded, or other bodies illuminated by them, in such a manner as that he could view them distinctly at the same time; and he either varied the distances of these bodies, or modified their light in some other way, till he could perceive no difference between them. Then, considering their different distances, or the other circumstances by which their light was affected, he calculated the proportion which they would have borne to each other at the same distance, or in the same circumstances.

Plate CCVI  
fig. 3.

To ascertain the quantity of light lost by reflection, he placed the mirror, or reflecting surface, B, on which the experiment was to be made, truly upright; and having taken two tablets, of precisely the same colour, or of an equal degree of whiteness, he placed them exactly parallel to one another at E and D, and threw light upon them by means of a lamp or candle, P, placed in a right line between them. He then placed himself so that, with his eye at A, he could see the tablet E, and the image of the tablet D, reflected from the mirror B, at the same time; making them, as it were, to touch one another. He then moved the candle along the line ED, so as to throw more or less light upon either of them, till he could perceive no difference in the strength of the light that came to his eye from them. After this, he had nothing more to do than to measure the distances EP and DP; for the squares of those distances expressed the degree in which the reflection of the mirror diminished the quantity of light. It is evident, that if the mirror reflected all the rays it received, the candle P must have been placed at C, at an equal distance from each of the tablets, in order to make them appear equally illuminated; but because much of the light is lost in reflection, they can only be made to appear equally bright by placing the candle nearer the tablet D, which is seen by reflection only.

Fig. 4.

To find how much light is lost by oblique reflection, he took two equally polished plates, D and E, and caused them to be enlightened by the candle P; and while one of them, D, was seen at A, by reflection from B, placed in a position oblique to the eye, the other, E, was placed, as to appear contiguous to it; and removing the plate E, till the light which it reflected was no stronger than that which came from the image D, seen by reflection at B, he estimated the

quantity of light that was lost by this oblique reflection, by the squares of the distances of the two objects from the candle.

It need scarcely be added, that, in these experiments all foreign light was excluded, that his eye was shaded, and that every other precaution was observed in order to make his conclusions unquestionable.

In order to ascertain the quantity of light lost by reflection with the greatest exactness, M. Bouguer introduced two beams of light into a darkened room, as by the apertures P and Q; which he had so contrived, that he could place them higher or lower, and enlarge or contract them at pleasure; and the reflecting surface (as that of a fluid contained in a vessel) was placed horizontally at O, from whence the light coming thro' the hole P, was reflected to R, upon the screen GH, where it was compared with another beam of light that fell upon S, through the hole Q; which he made so much less than P, as that the spaces S and R were equally illuminated; and by the proportion that the apertures P and Q bore to each other, he calculated what quantity of light was lost by the reflection at O.

Fig. 5.

It is necessary, he observes, that the two beams of light PO and QS (which he usually made 7 or 8 feet long) should be exactly parallel, that they might come from two points of the sky equally elevated above the horizon, and having precisely the same intensity of light. It was also necessary that the hole Q should be a little higher than P, in order that the two images should be at the same height, and near one another. It is no less necessary, he says, that the screen GH be exactly vertical, in order that the direct and reflected beams may fall upon it with the same inclination; since, otherwise, though the two lights were perfectly equal, they would not illuminate the screen equally. This disposition, he says, serves to answer another important condition in these experiments; for the direct ray QS must be of the same length with the sum of the incident and reflected rays, PO and OR, in order that the quantity of light introduced into the room may be sensibly proportional to the sizes of the apertures.

We shall now proceed to recite the result of the experiments which he made to measure the quantity of light that is lost by reflection in a great variety of circumstances; but we shall introduce them by the recital of some which were made previous to them on the diminution of light by reflection, and the transmission of it to considerable distances through the air, by M. Buffon, at the time that he was constructing his machine to burn at great distances, mentioned under the article *BURNING-Glass*.

Receiving the light of the sun in a dark place, and comparing it with the same light of the sun reflected by a mirror, he found, that at small distances, as four or five feet, about one half was lost by reflection; as he judged by throwing two reflected beams upon the same place, and comparing them with a beam of direct light; for then the intensity of them both seemed to be the same.

Having received the light at greater distances, as at 100, 200, and 300 feet, he could hardly perceive that it lost any of its intensity by being transmitted through such a space of air.

He afterwards made the same experiments with candles, in the following manner: He placed himself opposite

<sup>33</sup>  
Of Mr Buf-  
fon.

opposite to a looking-glass, with a book in his hand, in a room perfectly dark; and having one candle lighted in the next room, at the distance of about 40 feet, he had it brought nearer to him by degrees, till he was just able to distinguish the letters of the book, which was then 24 feet from the candle. He then received the light of the candle, reflected by the looking-glass, upon his book, carefully excluding all the light that was reflected from any thing else; and he found that the distance of the book from the candle, including the distance from the book to the looking-glass (which was only half a foot) was in all 15 feet. He repeated the experiment several times, and always with nearly the same result; and therefore concluded, that the quantity of direct light is to that of reflected as 576 to 225; so that the light of five candles reflected from a plane mirror is about equal to that of two candles.

From these experiments it appeared, that more light was lost by reflection of the candles than of the sun, which M. Buffon thought was owing to this circumstance, that the light issuing from the candle diverges, and therefore falls more obliquely upon the mirror than the light of the sun, the rays of which are nearly parallel.

These experiments and observations of M. Buffon are curious; though it will be seen that they fall far short of those of M. Bouguer, both in extent and accuracy. We shall begin with those which he made to ascertain the difference in the quantity of light reflected by glass and polished metal.

34  
Mr Bouguer's discoveries concerning the reflection of glass and polished metal.

Using a smooth piece of glass one line in thickness, he found, that when it was placed at an angle 15 degrees with the incident rays, it reflected 628 parts of 1000 which fell upon it; at the same time that a metallic mirror, which he tried in the same circumstances, reflected only 561 of them. At a less angle of incidence much more light was reflected; so that at an angle of three degrees the glass reflected 700 parts, and the metal something less, as in the former case.

Trying the reflection of bodies that were not polished, he found that a piece of white plaster, placed at an angle of 75°, with the incident rays, reflected  $\frac{1}{7}$  part of the light is received from a candle, nine inches from it. White paper, in the same circumstances, reflected in the same proportion; but at the distance of three inches, they both reflected 150 parts of 1000 that were incident.

Proceeding to make farther observations on the subject of reflected light, he premises the two following theorems, which he demonstrates geometrically.

1. When the luminous body is at an infinite distance, and its light is received by a globe, the surface of which has a perfect polish, and absorbs no light, it reflects the light equally in all directions, provided it be received at a considerable distance. He only excepts the place where the shadow of the globe falls; but this, he says, is no more than a single point, with respect to the immensity of the spherical surface which receives its light.

2. The quantity of light reflected in one certain direction will always be exactly the same, whether it be reflected by a very great number of small polished hemispheres, by a less number of larger hemispheres, or by a single hemisphere, provided they occupy the same base, or cover the same ground-plan.

The use he proposes to make of these theorems is to assist him in distinguishing whether the light reflected from bodies be owing to the extinction of it within them, or whether the roughness or eminences which cover them have not the same effect with the small polished hemispheres above-mentioned.

He begins with observing, that, of the light reflected from Mercury,  $\frac{1}{2}$  at least is lost, and that probably no substances reflect more than this. The rays were received at an angle of  $11\frac{1}{2}$  degrees of incidence, that is measured from the surface of the reflecting body, and not from the perpendicular, which, he says, is what we are from this place to understand whenever he mentions the angle of incidence.

The most striking observations which he made with respect to this subject, are those which relate to the very great difference in the quantity of light reflected at different angles of incidence. In general, he says, that reflection is stronger at small angles of incidence, and weaker at large ones. The difference is excessive when the rays strike the surface of transparent substances, with different degrees of obliquity; but it is almost as great in some opaque substances, and it was always more or less so in every thing that he tried. He found the greatest inequality in black marble; in which he was astonished to find, that, with an angle of  $30^{\circ} 35'$  of incidence, though not perfectly polished, yet it reflected almost as well as quick-silver. Of 1000 rays which it received, it returned 600; but when the angle of incidence was 14 degrees, it reflected only 156; when it was 30, it reflected 51; and when it was 80, it reflected only 23.

Similar experiments made with metallic mirrors always gave the differences much less considerable. The greatest was hardly ever an eighth or a ninth part of it, but they were always in the same way.

The great difference between the quantity of light reflected from the surface of water, at different angles of incidence, is truly surprising; but our author observes, that this difference was greater when the smallest inclinations were compared with those which were near to a right angle. He sometimes suspected that, at very small angles of incidence, the reflection from water was even greater than from quick-silver. All things considered, he thought it was not quite so great, though it was very difficult to determine the precise difference between them. In very small angles, he says, that water reflects nearly  $\frac{1}{3}$  of the direct light.

There is no person, he says, but has sometimes felt the force of this strong reflection from water, when he has been walking in still weather on the brink of a lake opposite to the sun. In this case, the reflected light is  $\frac{1}{2}$ ,  $\frac{1}{3}$ , or sometimes a greater proportion of the light that comes directly from the sun, which is an addition to the direct rays of the sun that cannot fail to be very sensible. The direct light of the sun diminishes gradually as it approaches the horizon, while the reflected light at the same time grows stronger; so that there is a certain elevation of the sun, in which the united force of the direct and reflected light will be the greatest possible, and this he says is 12 or 13 degrees.

On the other hand, the light reflected from water at great angles of incidence is extremely small. Our author was assured, that, when the light was perpendicular, it reflected no more than the 37th part that quick-

35  
Great differences in the reflective power of substances according to the angle of incidence.

quicksilver does in the same circumstances; for it did not appear, from all his observations, that water reflects more than the 60th, or rather the 55th, part of perpendicular light. When the angle of incidence was 50 degrees, the light reflected from the surface of water was about the 32d part of that which mercury reflected; and as the reflection from water increases with the diminution of the angle of incidence, it was twice as strong in proportion at 39 degrees; for it was then the 16th part of the quantity that mercury reflected.

In order to procure a common standard by which to measure the proportion of light reflected from various fluid substances, he pitched upon water as the most commodious; and partly by observation, and partly by calculation, which he always found to agree with his observations, he drew up the following table of the quantity of light reflected from the surface of water, at different angles with the surface.

Angles of incidence.	Rays reflected of 1000.	Angles of incidence.	Rays reflected of 1000.
$\frac{1}{2}$	721	$17 \frac{1}{2}$	178
1	692	20	145
$1 \frac{1}{2}$	669	25	97
2	639	30	65
$2 \frac{1}{2}$	614	40	34
5	501	50	22
$7 \frac{1}{2}$	409	60	19
10	333	70	18
$12 \frac{1}{2}$	271	80	18
15	211	90	18

In the same manner, he drew up the following table, of the quantity of light reflected from the looking-glass not quicksilvered.

Angles of incidence.	Rays reflected of 1000.	Angles of incidence.	Rays reflected of 1000.
$2 \frac{1}{2}$	584	30	112
5	543	40	57
$7 \frac{1}{2}$	474	50	34
10	412	60	27
$12 \frac{1}{2}$	356	70	25
15	299	80	25
20	222	90	25
25	157		

Pouring a quantity of water into a vessel containing quicksilver, it is evident that there will be two images of any objects seen by reflection from them, one at the surface of the water, and the other at that of the quicksilver. In the largest angles of incidence, the image at the surface of the water will disappear, which will happen when it is about a 60th or an 80th part less luminous than the image at the surface of the quicksilver. Depressing the eye, the image on the water will grow stronger, and that on the quicksilver weaker in proportion; till at last, the latter will be incomparably weaker than the former, and at an angle of about 10 degrees they will be equally luminous. According to the table,  $\frac{1}{1000}$  of the incident rays are reflected from the water at this angle of 10 degrees. At the surface of the mercury, they were reduced to

500; and of these, part being reflected back upon it from the under surface of the water, only 333 remained to make the image from the mercury.

It has been observed by several persons, particularly by Mr Edwards, (see Phil. Trans. vol. 53, p. 229.) that there is a remarkably strong reflection into water, with respect to rays issuing from the water; and persons under water have seen images of things in the water in a manner peculiarly distinct and beautiful: but this fact had not been observed with a sufficient degree of attention, till it came into M. Bouguer's way to do it, and he acknowledges it to be very remarkable. In this case, he says, that from the smallest angles of incidence, to a certain number of degrees, the greatest part of the rays are reflected, perhaps in as great a proportion as at the surface of metallic mirrors, or of quicksilver; while the other part, which does not escape into the air, is extinguished or absorbed; so that the surface of the transparent body appears opaque on the inside. If the angle of incidence be increased only a few degrees, the strong reflection ceases altogether, a great number of rays escape into the air, and very few are absorbed or extinguished. In proportion as the angle of incidence is farther increased, the quantity of the light reflected becomes less and less; and when it is near 90 degrees, almost all the rays escape out of the transparent body, its surface losing almost all its power of reflection, and becoming almost as transparent as it is in other cases, or when the light falls upon it from without.

This property belonging to the surfaces of transparent bodies, of absorbing or extinguishing the rays of light, is truly remarkable, and, as there is reason to believe, had not been noticed by any person before M. Bouguer. It had been conjectured by Sir Isaac Newton, that rays of light become extinct only by impinging upon the solid part of bodies; but these observations of M. Bouguer shew that the fact is quite otherwise; and that this effect is to be attributed, not to the solid parts of bodies, which are certainly more numerous in a long tract of water than just in the passage out of water into air, but to some power lodged at the surfaces of bodies only, and therefore probably the same with that which reflects, refracts, and reflects the light.

One of the above-mentioned observations, viz. all the light being reflected at certain angles of incidence from air into denser substances, had frequently been observed, especially in glass prisms; so that Newton made use of one of them instead of a reflecting mirror, in the construction of his telescope. If a beam of light fall upon the air from within these prisms, at an angle of 10, 20, or 30 degrees, the effect will be nearly the same as at the surface of quicksilver, a fourth or a third of the rays being extinguished, and  $\frac{2}{3}$  or  $\frac{1}{3}$  the reflected. This property retains its full force as far as an incidence of  $49^{\circ} 49'$ , (supposing the proportion of the sines of refraction to be 31 and 20 for the mean refrangible rays); but if the angle of incidence be increased but one degree, the quantity of light reflected inwards decreases suddenly, and a great part of the rays escape out of the glass, so that the surface becomes suddenly transparent.

All transparent bodies have the same property, with this difference, that the angle of incidence at which the

strong

36  
Reflection  
of images  
by the air.

37  
Extinction  
of the rays  
of light at  
the surfaces  
of transpa-  
rent bodies.

38  
Strong re-  
flection by a  
prism.]



From reflection ceases, and at which the light which is not reflected is extinguished, is greater in some than in others. In water this angle is about  $41^{\circ} 32'$ ; and in every medium it depends so much on the invariable proportion of the sine of the angle of refraction to the sine of the angle of incidence, that this law alone is sufficient to determine all the phenomena of this new circumstance, at least as to this accidental opacity of the surface.

When our author proceeded to measure the quantity of light reflected by these internal surfaces at great angles of incidence, he found many difficulties, especially on account of the many alterations which the light underwent before it came to his eye: but at length, using a plate of crystal, he found, that, at an angle of  $75$  degrees, this internal reflection diminished the light  $27$  or  $28$  times; and as the external reflection at the same angle diminished the light only  $26$  times, it follows that the internal reflection is a little stronger than the other.

Repeating these experiments with the same and different pieces of crystal, he sometimes found the two reflections to be equally strong; but, in general, the internal was the stronger. Also, the image reflected internally was always a little redder than an object which was seen directly through the plate of crystal.

<sup>30</sup> Returning his observations on the diminution of light, occasioned by the reflection of opaque bodies obliquely situated, he compared it with the appearances of similar substances which reflected the light perpendicularly. Using pieces of silver made very white, he found, that, when one of them was placed at an angle of  $75$  degrees with respect to the light, it reflected only  $640$  parts out of  $1000$ . He then varied the angle, and also used white plaster and fine Dutch paper, and drew up the following table of the proportion of the light reflected from each of those substances at certain angles.

INTENSITY OF LIGHT reflected from

Angles of incidence.	Silver.	Plaster.	Dutch Paper.
90	1000	1000	1000
75	802	762	971
60	640	640	743
45	455	529	507
30	319	352	332
15	209	194	203

Supposing the asperities of opaque bodies to consist of very small planes, it appears from these observations, that there are fewer of them in these bodies which reflect the light at small angles of incidence than at greater; and our author says, that the case was nearly the same with respect to all the opaque bodies that he tried. None of them had their roughness equivalent to small hemispheres, which would have dispersed the light equally in all directions; and, from the data in the preceding table, he deduces mathematically the number of the little planes that compose those surfaces, and that are inclined to the general surface at the angles above-mentioned, supposing that the whole surface contains  $1000$  of them that are parallel to itself, so as to reflect the light perpendicularly, when

the luminous body is situated at right angles with respect to it. His conclusions reduced to a table, corresponding to the preceding, are as follows:

Inclinations of the small surfaces with respect to the large one.	The distribution of the small planes that constitute the asperities of the opaque surface in the		
	Silver.	Plaster.	Paper.
0	1000	1000	1000
15	777	736	937
30	554	554	545
45	333	374	358
60	161	176	166
75	53	50	52

These variations in the number of little planes, or surfaces, he expresses in the form of a curve; and afterwards he shews, geometrically, what would be the effect, if the bodies were enlightened in one direction, and viewed in another; upon which subject he has several curious theorems and problems: as, the position of the eye being given, to find the angle at which the luminous body must be placed, in order to its reflecting the most light; or, the situation of the luminous body being given, to find a proper situation for the eye, in order to see it the most enlightened, &c. But it would carry us too far into geometry to follow him through all these difficulties.

Since the planets, as this accurate observer <sup>40</sup> notices, are more luminous at their edges than at their centres, he concludes, from the above-mentioned principles, that the bodies which form them are constituted in a manner different from ours; particularly that their opaque surfaces consist of small planes, more of which are inclined to the general surface than they are in terrestrial substances; and that there are in them an infinity of points, which have exactly the same splendour.

Our philosopher and geometrician next proceeds to ascertain the quantity of surface occupied by the small planes of each particular inclination, from considering the quantity of light reflected by each, allowing those that have a greater inclination to the common surface to take up proportionably less space than those which are parallel to it. And comparing the quantity of light that would be reflected by small planes thus disposed, with the quantity of light that was actually reflected by the three substances above-mentioned, he found, that plaster, notwithstanding its extreme whiteness, absorbs much light; for that, of  $1000$  rays that fall upon it, of which  $166$  or  $167$  ought to be reflected at an angle of  $77$  degrees, only  $67$  are in fact returned; so that  $100$  out of  $167$  were extinguished, that is, about three-fifths.

With respect to the planets, our author concludes, that of  $300,000$  rays which the moon receives,  $172,000$  are absorbed, or perhaps  $204,100$ .

Having considered the surfaces of bodies as consisting of planes only, he thus explains himself.—Each small surface, separately taken, is extremely irregular, bodies, and some of them are really concave, and others convex; but, in reducing them to a middle state, they are to be considered as planes. Nevertheless he considers

them as planes only with respect to the reception of the rays; for as they are almost all curves, and as, besides this, many of those whose situation is different from others contribute to the same effect, the rays always issue from an actual or imaginary focus, and after reflection always diverge from one another.

If it be asked what becomes of those rays that are reflected from one asperity to another, he shews that very few of the rays can be in those circumstances; since they must fall upon planes which have more than 45 degrees of obliquity to the surface, of which there are very few in natural bodies. These rays must also fall at the bottom of those planes, and must meet with other planes similarly situated to receive them; and considering the great irregularity of the surfaces of opaque bodies, it may be concluded that very few of the rays are thus reflected upon the body itself; and that the little that is so reflected is probably lost to the spectators, being extinguished in the body.

We are obliged to Mr Melville for some ingenious observations on the manner in which bodies are heated by light. He observes, that, as each colorific particle of an opaque body must be somewhat moved by the reaction of the particles of light, when it is reflected backwards and forwards between the same particles, it is manifest that they must likewise be agitated with a vibratory motion, and the time of a vibration will be equal to that which light takes up in moving from one particle of a body to another adjoining. This distance, in the most solid opaque bodies, cannot be supposed greater than  $\frac{1}{112}$  of an inch, which space a particle of light describes in the  $\frac{1}{112000000000000}$  of a second. With so rapid a motion, therefore, may the internal parts of bodies be agitated by the influence of light, as to perform 125,000,000,000,000 vibrations, or more, in a second of time.

The arrival of different particles of light at the surface of the same colorific particle, in the same or different rays, may disturb the regularity of its vibrations, but will evidently increase their frequency, or raise still smaller vibrations among the parts which compose those particles; by which means the intestine motion will become more subtle, and more thoroughly diffused. If the quantity of light admitted into the body be increased, the vibrations of the particles must likewise increase in magnitude and velocity, till at last they may be so violent, as to make all the component particles dash one another to pieces by their mutual collision; in which case, the colour and texture of the body must be destroyed.

Since there is no reflection of light but at the surface of a medium, the same person observes, that the greatest quantity of rays, though crowded into the smallest space, will not of themselves produce any heat. From hence it follows, that the portion of air which lies in the focus of the most potent speculum, is not at all affected by the passage of light through it, but continues of the same temperature with the ambient air; though any opaque body, or even any transparent body denser than air, when put in the same place, would be intensely heated in an instant.

This consequence, evidently flowing from the plainest and most certain principles, not seeming to have been rightly understood by many philosophers; and even the silence of most physical writers concerning this

paradoxical truth making it probable that they were unacquainted with it, he thought it worth his while to say something in explication of it. He observes, that the easiest way to be satisfied of the matter experimentally is, to hold a hair, or a piece of down, immediately above the focus of a lens or speculum, or to blow a stream of smoke from a pipe horizontally over it; for if the air in the focus were hotter than the surrounding fluid, it would continually ascend upon account of its rarefaction, and thereby sensibly agitate those slender bodies. Or a lens may be so placed as to form its focus within a body of water, or some other transparent substance, the heat of which may be examined from time to time with a thermometer; but care must be taken, in this experiment, to hold the lens as near as possible to the transparent body, lest the rays, by falling closer than ordinary on its surface, should warm it more than the common sunbeams.

To apply these observations to the explication of natural phenomena, he observes, that the atmosphere is not much warmed by the passage of the sun's light through it, but chiefly by its contact with the heated surface of the globe. This, he thought, furnished one very simple and plausible reason why it is coldest in all climates on the tops of very high mountains; namely, because they are removed to the greatest distance from the general surface of the earth. For it is well known, that a fluid heated by its contact with a solid body, decreases in heat in some inverse proportion to the distance from the body. He himself found, by repeated trials, that the heat of water in deep lakes decreases regularly from the surface downwards. But to have this question fully determined, the temperature of the air in the valley and on the mountain-top must be observed every hour, both night and day, and carefully compared together.

From this doctrine he thinks it reasonable to suppose, that the heat produced by a given number of rays, in an opaque body of a given magnitude, must be greater when the rays are more inclined to one another, than when they are less so; for the direction of the vibrations raised by the action of the light, whether in the colorific particles, or those of an inferior order, will more interfere with one another; from whence the intestine shocks and collisions must increase. Besides this, the colorific particles of opaque bodies being disposed in various situations, perhaps, upon the whole, the rays will fall more directly on each, the more they are inclined to one another. Is not this, says he, the reason of what has been remarked by philosophers, that the heat of the sun's light, collected into a cone, increases in approaching the focus in a much higher proportion than according to its density? That the difference of the angle in which the rays fall on any particle of a given magnitude, placed at different distances from the focus, is but small, is no proof that the phenomenon cannot be ascribed to it; since we know not in what high proportion one or both the circumstances now mentioned may operate. However, that it proceeds not from any unknown action of the rays upon one another, as has been insinuated, is evident from this, that each particular ray, after passing through the focus, preserves its own colour and its own direction, in the same manner

42  
Mr Melville's observations on the manner in which bodies are heated by light.

manner as if it were alone.

<sup>43</sup> Abbé Nollet's experiments with burning glasses.

The attempts of the Abbé Nollet to fire inflammable substances by the power of the solar rays collected in the foci of burning mirrors, have a near relation to the present subject. Considering the great power of burning mirrors and lenses, especially those of late construction, it will appear surprising that this celebrated experimental philosopher should not be able to fire any liquid substance. But though he made the trial with all the care imaginable on the 19th of February 1757, he was not able to do it either with spirit-of-wine, olive-oil, oil-of-turpentine, or æther; and though he could fire sulphur, yet he could not succeed with Spanish-wax, rosin, black pitch, or fuet. He both threw the focus of these mirrors upon the substances themselves, and also upon the fumes that rose from them; but all the effect was, that the liquor boiled, and was dispersed in vapour or very small drops, but would not take fire. When linen-rags, and other solid substances, were moistened with any of these inflammable liquids, they would not take fire till the liquid was dispersed in a copious fume; so that rags thus prepared were longer in burning than those that were dry.

<sup>44</sup> M. Beaume's experiments.

M. Beaume, who assisted M. Nollet in some of these experiments, observed farther, that the same substances which were easily fired by the flame of burning bodies, could not be set on fire by the contact of the hottest bodies that did not actually flame. Neither æther nor spirit-of-wine could be fired with a hot coal, or even red-hot iron, unless they were of a white heat. From these experiments our author concludes, that, supposing the electric matter to be the same thing with fire or light, it must fire spirit-of-wine by means of some other principle. The members of the academy Del Cimento had attempted to fire several of these substances, though without success; but this was so early in the history of philosophy, that nobody seems to have concluded, that, because they failed in this attempt, the thing could not be done. However, the Abbé informs us, that he read an account of his experiments to the Royal Academy at Paris several years before he attended to what had been done by the Italian philosophers.

<sup>45</sup> Bodies which seem to touch one another are not actually in contact.

By the help of optical principles, and especially observations on the reflection of light, Mr Melville discovered that bodies which seem to touch one another are not always in actual contact. "It is common (says he) to admire the volubility and lustre of drops of rain that lie on the leaves of colewort, and some other vegetables;" but no philosopher, as far as he knew, had put himself to the trouble of explaining this curious phenomenon. Upon inspecting them narrowly, he found that the lustre of the drop is produced by a copious reflection of light from the flattened part of its surface contiguous to the plant. He observed farther, that, when the drop rolls along a part which has been wetted, it immediately loses all its lustre, the green plant being then seen clearly through it; whereas, in the other case, it is hardly to be discerned.

From these two observations put together, he concluded, that the drop does not really touch the plant, when it has the mercurial appearance, but is suspended in the air at some distance from it by the force of a

repulsive power. For there could not be any copious reflection of white light from its under-surface, unless there were a real interval between it and the surface of the plant.

If that surface were perfectly smooth, the under-surface of the drop would be so likewise, and would therefore shew an image of the illuminating body by reflection, like a piece of polished silver; but as it is considerably rough and unequal, the under-surface becomes rough likewise, and so, by reflecting the light copiously in different directions, assumes the resplendent white colour of unpolished silver.

It being thus proved by an optical argument, that the drop is not really in contact with the plant which supports it, it may easily be conceived whence its volubility arises, and why it leaves no moisture where it rolls.

Before we conclude the history of the observations concerning the reflection of light, we must not omit to take notice of two curious miscellaneous ones. Baron Alexander Funk, visiting some silver-mines in Sweden, observed that, in a clear day, it was as dark as pitch under-ground in the eye of a pit, at 60 or 70 fathoms deep; whereas, in a cloudy or rainy day, he could even see to read at 106 fathoms deep. Inquiring of the miners, he was informed that this is always the case; and, reflecting upon it, he imagined that it arose from this circumstance, that when the atmosphere is full of clouds, light is reflected from them into the pit in all directions, and that thereby a considerable proportion of the rays are reflected perpendicularly upon the earth; whereas, when the atmosphere is clear, there are no opaque bodies to reflect the light in this manner, at least in a sufficient quantity; and rays from the sun itself can never fall perpendicularly in that country. The other was that of the ingenious Mr Grey, who makes such a figure in the history of electricity. This gentleman took a piece of stiff brown paper, and pricking a small hole in it, he held it at a little distance before him; when, applying a needle to his eye, he was surpris'd to see the point of it inverted. The nearer the needle was to the hole, the more it was magnified, but the less distinct; and if it was so held, as that its image was near the edge of the hole, its point seem'd crooked. From these appearances he concluded, that these small holes, or something in them, produce the effects of concave speculums; and from this circumstance he took the liberty to call them *aërial speculums*.

#### § 4. Discoveries concerning the Inflexion of Light.

This property of light was not discovered till about the middle of the last century. The person who first made the discovery was Father Grimaldi; at least he first published an account of it in his treatise *De lumine, coloribus, et iride*, printed in 1666. Dr Hooke, however, laid claim to the same discovery, though he did not publish his observations till six years after Grimaldi; having probably never seen his performance.

Dr Hooke having made his room completely dark, admitted into it a beam of the sun's light by a very small hole in a brass plate fixed in the window-shutter. This beam spreading itself, form'd a cone, the apex of which was in the hole, and the base was on a paper,

fo placed, as to receive it at some distance. In this image of the sun, thus painted on the paper, he observed, that the middle was much brighter than the edges, and that there was a kind of dark penumbra about it, of about a 16th part of the diameter of the circle; which penumbra, he says, must be ascribed to a property of light, which he promised to explain.— Having observed this at the distance of about two inches from the former, he let in another cone of light; and receiving the bases of them, at such a distance from the holes as that the circles intersected each other, he observed that there was not only a penumbra, or darker ring, encompassing the lighter circle, but a manifest dark line, or circle, which appeared even where the limb of the one interfered with that of the other. This appearance is distinctly represented, fig. 6.

Plate CCVI

Comparing the diameter of this base with its distance from the hole, he found it to be by no means the same as it would have been if it had been formed by straight lines drawn from the extremities of the sun's disk, but varied with the size of the holes, and the distance of the paper.

Struck with this appearance, he proceeded to make farther experiments concerning the nature of light thus transmitted. To give a just idea of which, he held an opaque body BB, fig. 7, so as to intercept the light that entered at a hole in the window-shutter O, and was received on the screen AP. In these circumstances, he observed, that the shadow of the opaque body (which was a round piece of wood, not bright or polished) was all over somewhat enlightened, but more especially towards the edge. Some persons who were present, imagining that this light within the shadow might be produced by some kind of reflection from the side of this opaque body, on account of its roundness; and others supposing it might proceed from some reflection from the sides of the hole in the piece of brass through which the light was admitted into the room; to obviate both these objections, he admitted the light through a hole burnt in a piece of pasteboard, and intercepted it with a razor which had a very sharp edge; but still the appearances were the very same as before: so that, upon the whole, he concluded that they were occasioned by a new property of light, different from any that had been observed by preceding writers.

He farther diversified this experiment, by placing the razor so as to divide the cone of light into two parts, the hole in the shutter remaining as before, and placing the paper so as that none of the enlightened part of the circle fell upon it, but only the shadow of the razor; and, to his great surprise, he observed what he calls a *very brisk and visible radiation* striking down upon the paper, of the same breadth with the diameter of the lucid circle; and this radiation always struck perpendicularly from the line of shadow, and, like the tail of a comet, extended more than 10 times, and probably more than 100 times the breadth of the remaining part of the circle: nay, as far as he could find, by many trials, the light from the edge struck downwards into the shadow very near to a quadrant, though the greater were the deflections of this new light from the direct radiations of the cone, the more faint they were.

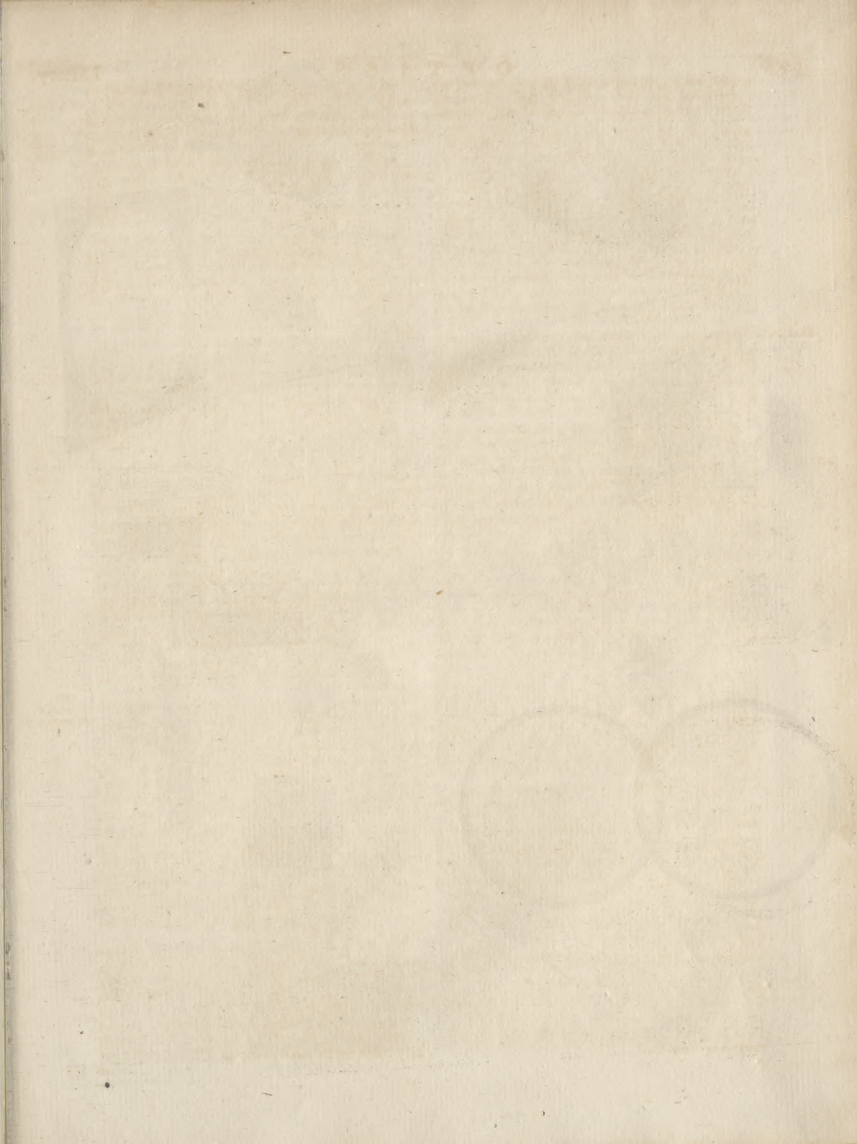
Observing this appearance with more attention, he found, wherever there was a part of the interposed body higher than the rest, that, opposite to it, the radiation of light into the shadow was brighter, as in the figure; and wherever there was a notch or gap in it, there would be a dark stroke in the half-enlightened shadow. From all these appearances, he concluded that they were to be ascribed to a new property of light, whereby it is deflected from straight lines, contrary to what had been before asserted by optical writers.

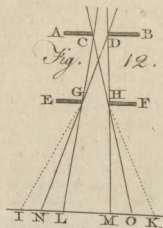
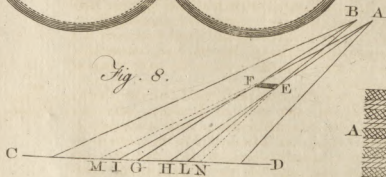
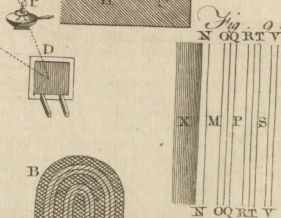
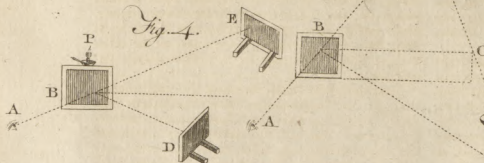
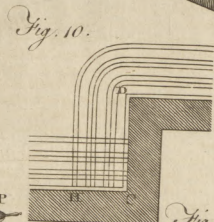
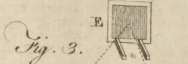
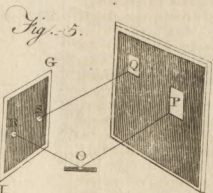
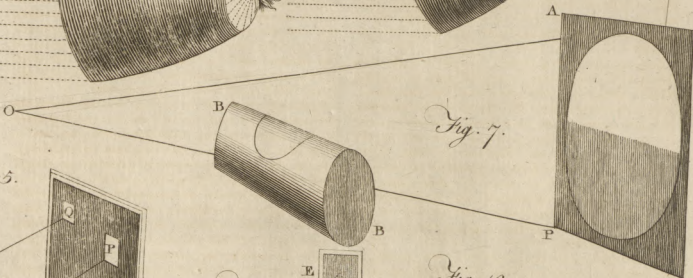
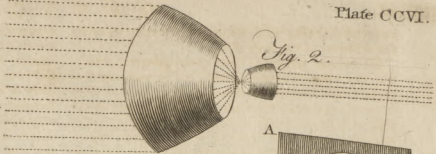
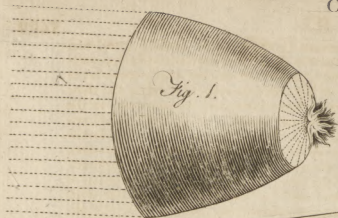
It does not appear, however, that our philosopher ever prosecuted this experiment to any purpose; as all that we find of his on the subject of light, after this time, are some crude thoughts which he read at a meeting of the Royal Society, on the 18th of March 1675; which, however, as they are only short hints, we shall copy.

They consist of eight articles; and, as he thought, contained an account of several properties of light, that had not been noticed before. There is a deflection of light, differing both from reflection and refraction, and seeming to depend on the unequal density of the constituent parts of the ray, whereby the light is dispersed from the place of condensation, and rarified, or gradually diverged into a quadrant. 2. This deflection is made towards the superficies of the opaque body perpendicularly. 3. Those parts of the diverged radiations which are deflected by the greatest angle from the straight or direct radiations are the faintest, and those that are deflected by the least angles are the strongest. 4. Rays cutting each other in one common foramen do not make the angles at the vertex equal. 5. Colours may be made without refraction. 6. The diameter of the sun cannot be truly taken with common sights. 7. The same rays of light, falling upon the same point of an object, will turn into all sorts of colours, by the various inclination of the object. 8. Colours begin to appear when two pulses of light are blended so well, and so near together, that the sense takes them for one.

We shall now proceed to the discoveries of Father <sup>48</sup>Grimaldi's discoveries. Grimaldi. Having introduced a ray of light, through a very small hole, AB, fig. 8. into a darkened room, he observed that the light was diffused in the form of a cone, the base of which was CD; and that if any opaque body, FE, was placed in this cone of light, at a considerable distance from the hole, and the shadow was received upon a piece of white paper, the boundaries of it were not confined within GH, or the penumbra IL, occasioned by the light proceeding from different parts of the aperture, and of the disk of the sun, but extended to MN; at which he was very much surprised, suspecting, and finding by calculation, that it was considerably broader than it could have been made by rays passing in right lines by the edges of the object.

But the most remarkable circumstance in this appearance was, that upon the lucid part of the base, CM and ND, streaks of coloured light were plainly distinguished, each being terminated by blue on the side next to the shadow, and by red on the other; and though these coloured streaks depended, in some measure, on the size of the aperture AB, because they could not be made to appear if it was large, yet





A. Bell's sculp. E

he found that they were not limited either by it, or by the diameter of the sun's disk.

He farther observed, that these coloured streaks were not all of the same breadth, but grew narrower as they receded from the shadow, and were each of them broader the farther the shadow was received from the opaque body, and also the more obliquely the paper on which they were received was held with respect to it. He never observed more than three of these streaks.

To give a clearer idea of these coloured streaks, he drew the representation of them, exhibited in fig. 9. in which NMO represents the broadest and most luminous streak, next to the dark shadow X. In the space in which M is placed there was no distinction of colour, but the space NN was blue, and the space OO, on the other side of it, was red. The second streak, QPR, was narrower than the former; and of the three parts of which it consisted, the space P had no particular colour, but QQ was a faint blue, and RR a faint red. The third streak, TSV, was exactly similar to the two others, but narrower than either of them, and the colours still fainter.

These coloured streaks he observed to lie parallel to the shadow of the opaque body; but when it was of an angular form, they did not make the same acute angles, but were bent into a curve, the outermost being rounder than those that were next the shadow, as is represented in fig. 10. If it was an inward angle, as DCH, the coloured streaks, parallel to each other of the two sides, crossed without obliterating one another; only the colours were thereby rendered either more intense, or mixed.

The light that formed these coloured streaks, the reader will perceive, must have been bent from the body; but this attentive observer has likewise given an account of other appearances, which must have been produced by the light bending towards the body. For within the shadow itself he sometimes perceived coloured streaks, similar to those above-mentioned on the outside of the shadow. Sometimes he saw more of them, and sometimes fewer: but for this purpose a very strong light was requisite, and the opaque body was obliged to be long, and of a moderate breadth; which, he says, is easily found by experience. A hair, for instance, or a fine needle, did not answer so well as a thin and narrow plate; and the streaks were most distinguishable when the shadow was taken at the greatest distance; but then the light grew fainter in the same proportion.

The number of these streaks within the shadow was greater in proportion to the breadth of the plate. They were at least two, and sometimes four, if a thicker rod were made use of. But, with the same plate or rod, more or fewer streaks appeared, in proportion to the distance at which the shadow was received; but they were broader when they were few, and narrower when there were more of them; and they were all much more distinct when the paper was held obliquely.

These coloured streaks within the shadow, like those on the outside of it, were bent in an arch, round the acute angles of the shadow, as they are represented in fig. 11. At this angle also, as at D, other shorter lucid streaks were visible, bent in the form of a plume, as they are

drawn betwixt D and C, each bending round and meeting again in D. These angular streaks appeared, though the plate or rod was not wholly immersed in the beam of light, but the angle of it only; and there were more or fewer in number, in proportion to the breadth of the rod or plate. If the plate or rod was very thin, the coloured streaks within the shadow might be seen to bend round from the opposite sides, and meet one another, as at B. A only represents a section of the figure, and not a proper termination of the shadow, and the streaks within each side of it. The coloured streaks without the shadow, he also observes, bend round it in the same manner.

Our author acknowledges, that he omits several observations of less consequence, which cannot but occur to any person who shall make the experiment; and he says, that he was not able to give a perfectly clear idea of what he has attempted to describe, nor does he think it in the power of words to do it.

In order to obtain the more satisfactory proof that rays of light do not always proceed in straight lines, but really bend, in passing by the edges of bodies, he diversified the first of the above-mentioned experiments in the following manner. He admitted a beam of light, by a very small aperture, into a darkened room, as before; and, at a great distance from it, he fixed a plate EF, fig. 12. with a small aperture, GH, which admitted only a part of the beam of light, and found, that when the light transmitted through this plate, was received at some distance, upon a white paper, the base IK was considerably larger than it could possibly have been made by rays issuing in the light lines through the two apertures, as the other straight lines drawn close to their edges plainly demonstrate.

That those who choose to repeat these experiments may not be disappointed in their expectations from them, our author gives the following more particular instructions. The sun's light must be very intense, and the apertures through which it is transmitted very narrow, particularly the first, CD, and the white paper, IK, on which it is received, must be at a considerable distance from the hole GH; otherwise it will not much exceed NO, which would be the breadth of the beam of light proceeding in straight lines. He generally made the aperture  $CD \frac{4}{100}$  or  $\frac{1}{100}$  part of an ancient Roman foot, and the second aperture, GH,  $\frac{2}{100}$  or  $\frac{1}{100}$ ; and the distances DG and GN were, at least, 12 such feet. The observation was made in the summer-time, when the atmosphere was free from all vapours, and about mid-day.

F. Grimaldi also made the same experiment that has been recited from Dr Hooke, in which two beams of light, entering a darkened room by two small apertures near to one another, projected cones of light, which, at a certain distance, in part coincided; and he particularly observed that the dark boundaries of each of them were visible within the lucid ground of the other.

To these discoveries of Grimaldi, we shall subjoin <sup>49</sup> an additional observation of Dechales; who took of Dechales notice, that if small scratches be made in any piece of polished metal, and it be exposed to the beams of the sun in a darkened room, it will reflect the rays streaked with colours in the direction of the scratches.

ches; as will appear if the reflected light be received upon a piece of white paper. That these colours are not produced by refraction, he says, is manifest; for that, if the scratches be made upon glass, the effect will be the same; and in this case, if the light had been refracted at the surface of the glass, it would have been transmitted through it. From these, and many other observations, he concludes that colour does not depend upon the refraction of light only, nor upon a variety of other circumstances, which he particularly enumerates, and the effects of which he discusses, but upon the intensity of the light only.

50  
Of M. De  
la Hire.

We shall here give an account of a phenomenon of vision observed by M. De la Hire, because the subject of this section, viz. the *inflection of light*, seems to supply the true solution of it, though the author himself thought otherwise. It is observable, he says, that when we look at a candle, or any luminous body, with our eyes nearly shut, rays of light are extended from it, in several directions, to a considerable distance, like the tails of comets. This appearance exercised the sagacity of Descartes and Rohault, as well as of our author; but all three seem to have been mistaken with respect to it. Descartes ascribed this effect to certain wrinkles in the surface of the humours of the eye. Rohault says, that when the eye-lids are nearly closed, the edges of them act like convex lenses. But our author says, that the moisture on the surface of the eye, adhering partly to the eye itself, and partly to the edge of the eye-lid, makes a concave mirror, and so disperses the rays at their entrance into the eye. But the true reason seems to be, that the light passing among the eye-lashes, in this situation of the eye, is inflected by its near approach to them, and therefore enters the eye in a great variety of directions. The two former of these opinions are particularly stated and objected to by our author.

51  
Sir Isaac  
Newton's  
discoveries.

The experiments of Father Grimaldi and Dr Hooke were not only repeated with the greatest care by Sir Isaac Newton, but carried much farther than they had thought of. So little use had been made of Grimaldi's observations, that all philosophers before Newton had ascribed the broad shadows, and even the fringes of light which he described, to the ordinary refraction of the air; but we shall see them placed in a very different point of view by our author.

Plate  
CCVII.

He made in a piece of lead a small hole with a pin, the breadth of which was the 42d part of an inch. Through this hole he let into his darkened chamber a beam of the sun's light; and found, that the shadows of hairs, and other slender substances placed in it, were considerably broader than they would have been, if the rays of light had passed by those bodies in right lines. He therefore concluded, that they must have passed as they are represented in fig. 1. in which X represents a section of the hair, and AD, BE, &c. rays of light passing by at different distances, and then falling upon the wall GQ. Since, when the paper which receives the rays is at a great distance from the hair, the shadow is broad, it must follow, as he observes, that the hair acts upon the rays of light at some considerable distance from it, the action being strongest on those rays which are at the least distance, and growing weaker and weaker on those which are farther off, as is represented in this figure; and from hence it came to

pass, that the shadow of the hair is much broader in proportion to the distance of the paper from the hair when it is nearer than when it is at a great distance.

He found, that it was not material whether the hair was surrounded with air, or with any other pellucid substance; for he wetted a polished plate of glass, and laid the hair in the water upon the glass, and then laying another polished plate of glass upon it, so that the water might fill up the space between the glasses, and holding them in the beam of light, he found the shadow at the same distances was as big as before. Also the shadows of scratches made in polished plates of glass, and the veins in the glass, cast the like broad shadows; so that this breadth of shadow must proceed from some other cause than the refraction of the air.

The shadows of all bodies, metals, stones, glass, wood, horn, ice, &c. in this light were bordered with three parallel fringes, or bands of coloured light, of which that which was contiguous to the shadow was the broadest and most luminous, while that which was the most remote was the narrowest, and so faint as not easily to be visible. It was difficult to distinguish these colours, unless when the light fell very obliquely upon a smooth paper, or some other smooth white body, so as to make them appear much broader than they would otherwise have done; but in these circumstances the colours were plainly visible, and in the following order. The first or innermost fringe was violet, and deep blue next the shadow, light blue, green, and yellow in the middle, and red without. The second fringe was almost contiguous to the first, and the third to the second; and both were blue within, and yellow and red without; but their colours were very faint, especially those of the third. The colours, therefore, proceeded in the following order from the shadows: violet, indigo, pale blue, green, yellow, red; blue, yellow, red; pale blue, pale yellow, and red. The shadows made by scratches and bubbles in polished plates of glass were bordered with the like fringes of coloured light.

He also observes, that by looking on the sun thro' a feather, or black ribbon, held close to the eye, several rainbows will appear, the shadows which the fibres or threads cast on the retina being bordered with the like fringes of colours.

Measuring these fringes and their intervals with the greatest accuracy, he found the former to be in the progression of the numbers 1,  $\sqrt{\frac{1}{2}}$ ,  $\sqrt{\frac{2}{3}}$ , and their intervals to be in the same progression with them, that is, the fringes and their intervals together to be in continual progression of the numbers 1,  $\sqrt{\frac{1}{2}}$ ,  $\sqrt{\frac{2}{3}}$ ,  $\sqrt{\frac{3}{4}}$ ,  $\sqrt{\frac{4}{5}}$ , or thereabouts. And these proportions held the same very nearly at all distances from the hair, the dark intervals of the fringes being as broad in proportion to the breadth the fringes at their first appearance as afterwards, at great distances from the hair, though not so dark and distinct.

In the next observation of our author, we find a very remarkable and curious appearance, which we should hardly have expected from the circumstances, though it is pretty similar to one that was noticed by Dr Hooke. The sun shining into his darkened chamber, through a hole  $\frac{1}{2}$  of an inch broad, he placed, at the distance of two or three feet from the hole, a sheet of paste-board,



board, black on both sides; and in the middle of it he had made a hole about  $\frac{1}{2}$  of an inch square, for the light to pass through; and behind the hole he fastened to the pasteboard the blade of a sharp knife, to intercept some part of the light which passed thro' the hole. The planes of the pasteboard and blade of the knife were parallel to one another, and perpendicular to the rays; and when they were so placed that none of the light fell on the pasteboard, but all of it passed through the hole to the knife, and there part of it fell upon the blade of the knife, and part of it passed by its edge, he let that part of the light which passed by fall on a white paper, 2 or 3 feet beyond the knife, and there saw two streams of faint light shoot out both ways from the beam of light into the shadow, like the tails of comets. But because the sun's direct light, by its brightness upon the paper, obscured these faint streams, so that he could scarce see them, he made a little hole in the middle of the paper for that light to pass through and fall on a black cloth behind it; and then he saw the two streams plainly. They were like one another, and pretty nearly equal in length, breadth, and quantity of light. Their light, at that end which was next to the sun's direct light, was pretty strong for the space of about  $\frac{1}{2}$  of an inch, or  $\frac{2}{3}$  of an inch, and decreased gradually till it became insensible.

The whole length of either of these streams, measured upon the paper, at the distance of 3 feet from the knife, was about 6 or 8 inches; so that it subtended an angle, at the edge of the knife, of about 10 or 12, or at most 14 degrees. Yet sometimes he thought he saw it shoot 3 or 4 degrees farther; but with a light so very faint, that he could hardly perceive it. This light he suspected might, in part at least, arise from some other cause than the two streams. For, placing his eye in that light, beyond the end of that stream which was behind the knife, and looking towards the knife, he could see a line of light upon its edge; and that not only when his eye was in the line of the streams, but also when it was out of that line, either towards the point of the knife, or towards the handle. This line of light appeared contiguous to the edge of the knife, and was narrower than the light of the innermost fringe, and narrowest when his eye was farthest from the direct light; and therefore seemed to pass between the light of that fringe and the edge of the knife; and that which passed nearest the edge seemed to be most bent, though not all of it.

He then placed another knife by the former, so that their edges might be parallel, and look towards one another, and that the beam of light might fall upon both the knives, and some part of it pass between their edges. In this situation he observed, that when the distance of their edges was about the 400th part of an inch, the stream divided in the middle, and left a shadow between the two parts. This shadow was so black and dark, that all the light which passed between the knives seemed to be bent and turned aside to the one hand or the other; and as the knives still approached one another, the shadow grew broader, and the streams shorter, next to it, till, upon the contact of the knives, all the light vanished.

From this experiment our author concludes, that the light which is least bent, and which goes to the inward ends of the streams, passes by the edges of the knives

at the greatest distance; and this distance, when the shadow began to appear between the streams, was about the 800th part of an inch; and the light which passed by the edges of the knives at distances still less and less, was more and more faint, and went to those parts of the streams which were farther from the direct light; because, when the knives approached one another till they touched, those parts of the streams vanished last which were farthest from the direct light.

In the experiment of one knife only, the coloured fringes did not appear; but, on account of the breadth of the hole in the window, became so broad as to run into one another, and, by joining, to make one continual light in the beginning of the streams; but in the last experiment, as the knives approached one another, a little before the shadow appeared between the two streams, the fringes began to appear on the inner ends of the streams, on either side of the direct light, three on one side, made by the edge of one knife, and three on the other side, made by the edge of the other knife. They were the most distinct when the knives were placed at the greatest distance from the hole in the window, and became still more distinct by making the hole less; so that he could sometimes see a faint trace of a 4th fringe, beyond the three above-mentioned; and as the knives approached one another, the fringes grew more distinct and larger, till they vanished; the outermost vanishing first, and the innermost last. After they were all vanished, and the line of light which was in the middle between them was grown very broad, extending itself on both sides into the streams of light described before, the above-mentioned shadow began to appear in the middle of this line, and to divide it along the middle into two lines of light, and increased till all the light vanished. This enlargement of the fringes was so great, that the rays which went to the innermost fringe seemed to be bent about 20 times more when the fringe was ready to vanish, than when one of the knives was taken away.

From both these experiments compared together, our author concludes, that the light of the first fringe passed by the edge of the knife at a distance greater than the 800th part of an inch, that the light of the second fringe passed by the edge of the knife at a greater distance than the light of the first fringe, and that of the third at a greater distance than that of the second; and that the light of which the streams above-mentioned consisted, passed by the edges of the knives at less distances than that of any of the fringes.

He then got the edges of two knives ground truly straight, and pricking their points into a board, so that their edges might look towards one another, and meeting near their points, contain a rectilinear angle, he fastened their handles together, to make the angle invariable. The distance of the edges of the knives from one another, at the distance of 4 inches from the angular point, where the edges of the knives met, was the 8th part of an inch, so that the angle contained by their edges was about  $1^{\circ} 54'$ . The knives being thus fixed together, he placed them in a beam of the sun's light let into his darkened chamber, thro' a hole the 42d part of an inch wide, at the distance of 10 or 13 feet from the hole; and he let the light which passed between their edges fall very obliquely on a smooth.

smooth white ruler, at the distance of  $\frac{1}{2}$  inch, or an inch, from the knives; and there he saw the fringes made by the two edges of the knives run along the edges of the shadows of the knives, in lines parallel to those edges, without growing sensibly broader, till they meet in angles equal to the angle contained by the edges of the knives; and where they met and joined they ended, without crossing one another. But if the ruler was held at a much greater distance from the knives, the fringes, where they were farther from the place of their meeting, were a little narrower, and they became something broader as they approached nearer to one another, and after they met they crossed one another, and then became much broader than before.

From these observations he concluded, that the distances at which the light composing the fringes passed by the knives were not increased or altered by the approach of the knives, but that the angles in which the rays were there bent were much increased by that approach, and that the knife which was nearest to any ray determined which way the ray should be bent, but that the other knife increased the bending.

When the rays fell very obliquely upon the ruler, at the distance of a third part of an inch from the knives, the dark line between the first and second fringe of the shadow of one knife, and the dark line between the first and second fringe of the shadow of the other knife, met one another, at the distance of the fifth part of an inch from the end of the light which passed between the knives, where their edges met one another; so that the distance of the edges of the knives, at the meeting of the dark lines, was the 160th part of an inch; and one half of that light passed by the edge of one knife, at a distance not greater than the 320th part of an inch, and, falling upon the paper, made the fringes of the shadow of that knife; while the other half passed by the edge of the other knife, at a distance not greater than the 320th part of an inch, and, falling upon the paper, made the fringes of the shadow of the other knife. But if the paper was held at a distance from the knives greater than the third part of an inch, the dark lines above-mentioned met at a greater distance than the fifth part of an inch from the end of the light which passed between the knives, at the meeting of their edges; so that the light which fell upon the paper where those dark lines met passed between the knives, where their edges were farther distant than the 160th part of an inch. For at another time, when the two knives were 8 feet and 5 inches from the little hole in the window, the light which fell upon the paper where the above-mentioned dark lines met passed between the knives, where the distance between their edges was, as in the following table, at the distances from the paper there noted.

Distances of the paper from the knives in inches.	Distances between the edges of the knives in millesimal parts of an inch.
1 $\frac{1}{2}$	0,012
3	0,020
8 $\frac{1}{2}$	0,034
32	0,057
96	0,081
131	0,087

From these observations he concluded, that the light which makes the fringes upon the paper is not the same light at all distances of the paper from the knives; but that, when the paper is held near the knives, the fringes are made by light which passes by the edges of the knives at a less distance, and is more bent than when the paper is held at a greater distance from the knives.

When the fringes of the shadows of the knives fell perpendicularly upon the paper, at a great distance from the knives, they were in the form of hyperbolas, their dimensions being as follows. Let CA, CB, represent lines drawn upon the paper, parallel to the edges of the knives; and between which all the light would fall if it suffered no inflection. DE is a right line drawn through C, making the angles ACD, BCE, equal to one another, and terminating all the light which falls upon the paper, from the point where the edges of the knives meet. Then *eis*, *fk*, and *gl*, will be three hyperbolical lines, representing the boundaries of the shadow of one of the knives, the dark line between the first and second fringes of that shadow, and the dark line between the second and third fringes of the same shadow. Also *xip*, *ykg*, and *zlr*, will be three other hyperbolical lines, representing the boundaries of the shadow of the other knife, the dark line between the first and second fringes of that shadow, and the dark line between the second and third fringes of the same shadow. These three hyperbolas are similar, and equal to the former three, and cross them in the points *i*, *k*, and *l*; so that the shadows of the knives are terminated, and distinguished from the first luminous fringes, by the lines *eis* and *xip*, till the meeting and crossing of the fringes; and then those lines cross the fringes in the form of dark lines terminating the first luminous fringes on the inside, and distinguishing them from another light, which begins to appear at *i*, and illuminates all the triangular space *ies* DE*s*, comprehended by these dark lines and the right line DE. Of these hyperbolas one asymptote is the line DE, and the other asymptotes are parallel to the lines CA and CB.

The sun shining into his darkened room through the small hole mentioned above, he placed at the hole a prism to refract the light, and to form on the opposite wall the coloured image of the sun; and he found, that the shadows of all bodies held in the coloured light between the prism and the wall, were bordered with fringes of the colour of that light in which they were held; and comparing the fringes made in the several coloured lights, he found, that those made in the red light were the largest, those made in the violet were the least, and those made in the green were of a middle bigness. For the fringes with which the shadow of a man's hair were bordered, being measured cross the shadow, at the distance of six inches from the hair, the distance between the middle and most luminous part of the first or innermost fringe on one side of the shadow, and that of the like fringe on the other side of the shadow, was, in the full red light  $\frac{1}{72}$  of an inch, and in the full violet  $\frac{1}{12}$ . The like distance between the middle and most luminous parts of the second fringes, on either side of the shadow, was in the full red light  $\frac{1}{27}$ , and the violet  $\frac{1}{7}$  of an inch; and these distances of the fringes held the same proportion

portion at all distances from the hair, without any sensible variation.

From these observations it was evident, that the rays which made the fringes in the red light, passed by the hair at a greater distance than those which made the like fringes in the violet; so that the hair, in causing these fringes, acted alike upon the red light or least refrangible rays at a greater distance, and upon the violet or most refrangible rays at a less distance; and thereby occasioned fringes of different sizes, without any change in the colour of any sort of light.

It may therefore be concluded, that when the hair in the first observation was held in the white beam of the sun's light, and cast a shadow which was bordered with three fringes of coloured light, those colours arose not from any new modifications impressed upon the rays of light by the hair, but only from the various inflections whereby the several sorts of rays were separated from one another, which before separation, by the mixture of all their colours, composed the white beam of the sun's light; but, when separated, composed lights of the several colours which they are originally disposed to exhibit.

<sup>53</sup>  
Maraldi's  
discoveries.

The person whose name we find first upon the list of those who pursued any experiments similar to those of Newton on inflected light is M. Maraldi; whose observations chiefly respect the inflection of light towards other bodies, whereby their shadows are partially illuminated; and many of the circumstances which he noticed relating to it are well worthy of our attention, as the reader will be convinced from the following account of them.

<sup>53</sup>  
Experiments concerning the shadows of cylinders.

He exposed in the light of the sun a cylinder of wood three feet long, and 6½ lines in diameter; when its shadow, being received upon a paper held close to it, was every where equally black and well defined, and continued to be so to the distance of 23 inches from it. At a greater distance the shadow appeared to be of two different densities; for the two extremities of the shadow, in the direction of the length of the cylinder, were terminated by two dark strokes, a little more than a line in breadth. Within these dark lines there was a faint light, equally dispersed through the shadow, which formed an uniform penumbra, much lighter than the dark strokes at the extremity, or than the shadow received near the cylinder. This appearance is represented in Plate CCVII. fig. 3.

As the cylinder was removed to a greater distance from the paper, the two black lines continued to be nearly of the same breadth, and the same degree of obscurity; but the penumbra in the middle grew lighter, and its breadth diminished, so that the two dark lines at the extremity of the shadow approached one another, till, at the distance of 60 inches, they coincided, and the penumbra in the middle entirely vanished. At a still greater distance a faint penumbra was visible, but it was ill defined, and grew broader as the cylinder was removed farther off, but was sensible at a very great distance.

Besides the black and dark shadow, which the cylinder formed near the opaque body, a narrow and faint penumbra was seen on the outside of the dark shadow. And on the outside of this there was a tract more strongly illuminated than the rest of the paper.

The breadth of the external penumbra increased with

the distance of the shadow from the cylinder, and the breadth of the tract of light on the outside of it was also enlarged; but its splendor diminished with the distance.

He repeated these experiments with three other cylinders of different dimensions; and from them all he inferred, that every opaque cylindrical body, exposed to the light of the sun, makes a shadow which is black and dark to the distance of 38 to 45 diameters of the cylinder which forms it; and that, at a greater distance, the middle part begins to be illuminated in the manner described above.

In explaining these appearances, our author supposes that the light which dilutes the middle part of the shadow was occasioned by the inflection of the rays, which, bending inwards on their near approach to the body, did at a certain distance enlighten all the shadow, except the edges, which was left undisturbed. At the same time other rays were deflected from the body, and formed a strong light on the outside of the shadow, and which might at the same time contribute to dilute the outer shadow, though he supposed that penumbra to be occasioned principally by that part of the paper not being enlightened, except by a part of the sun's disk only, according to the known principles of optics.

The same experiments he made with globes of several diameters; but he found, that, whereas the shadows of <sup>54</sup>the cylinders did not disappear but at the distance of 41 of their diameters, those of the globes were not visible beyond 15 of their diameters; which he thought was owing to the light being inflected on every side of a globe, and consequently in such a quantity as to disperse the shadows sooner than in the case of the cylinders.

In all these cases the penumbra occasioned by the inflected light, began to be visible at a less distance from the body in the stronger light of the sun than in a weaker, on account of the greater quantity of rays inflected in those circumstances.

Considering the analogy between these experiments <sup>55</sup>and the phenomena of an eclipse of the moon, immiser concerning sed in the shadow of the earth, he imagined, that part the moon of the light by which she is then visible is inflected light, and not that which is refracted by the atmosphere; though this may be so copious as to efface several of the above-mentioned appearances, occasioned by inflected light only. But this gentleman should have considered, that as no light is inflected but what passes exceedingly near to any body, perhaps so near as the distance of  $\frac{1}{40}$  part of an inch, this cause must be altogether inadequate to the effect.

Being sensible that the above-mentioned phenomena of the shadows were caused by inflected light, he was induced to give more particular attention to this remarkable property; and in order to it to repeat the experiments of Grimaldi and Sir Isaac Newton in a darkened room. In doing this, he presently observed, that, besides the enlarged shadow of a hair, a fine needle, &c. the bright gleam of light that bordered it, and the three coloured rings next to this enlightened part, when the shadow was at a considerable distance from the hair, the dark central shadow was divided in the middle by a mixture of light; and that it was not of the same density, except when it was very near the hair.

This new appearance will be seen to be exactly similar to what our philosopher had observed with respect to the shadows in the open day-light above-mentioned; but the following observations, which he made with some variation of his apparatus, are much more curious and striking, though they arise from the same cause.

Having placed a bristle, which is thicker than a common hair, in the rays of the sun, admitted into a dark chamber by a small hole, at the distance of nine feet from the hole, it made a shadow, which, being received at five or six feet from the object, he observed to consist of several streaks of light and shade. The middle part was a faint shadow, or rather a kind of penumbra, bordered by a darker shadow, and after that by a narrower penumbra, next to which was a light streak broader than the dark part, and next to the streak of light the red, violet, and blue colours were seen as in the shadow of the hair.

In the same manner he placed, in the same rays of the sun, several needles of different sizes; but the appearances were so exceedingly various, tho' sufficiently singular, that he does not recite them particularly, but chooses rather to give, at some length, the observations he made on the shadows of two plates, as by that means he could better explain the phenomena of the round bodies.

56  
Experiments concerning the shadows of metalline plates.

He exposed in the rays of the sun, admitted by a small hole into a dark chamber, a plate that was two inches long, and a little more than half a line broad. This plate being fixed perpendicularly to the rays, at the distance of nine feet from the hole, a faint light was seen uniformly dispersed over the shadow, when it was received perpendicularly to it, and very near. The shadow of the same plate being received at the distance of two feet and a half, was divided into four very narrow black streaks, separated by small lighter intervals equal to them. The boundaries of this shadow on each side had a penumbra, which was terminated by a very strong light, next to which were the coloured streaks of red, violet, and blue, as before. This is represented in Plate CCVII. fig. 4.

The shadow of the same plate at  $4\frac{1}{2}$  feet distance from it, was divided into two black streaks only, the two outermost having disappeared, as in fig. 5; but these two black streaks which remained were broader than before, and separated by a lighter shade, twice as broad as one of the former black streaks, when the shadow was taken at  $2\frac{1}{2}$  feet. This penumbra in the middle had a tinge of red. After the two black streaks there appeared a pretty strong penumbra, terminated by the two streaks of light, which were now broad and splendid, after which followed the coloured streaks.

A second plate, two inches long and a line broad, being placed like the former, 14 feet from the hole by which the rays of the sun were admitted, its shadow being received perpendicularly very near the plate, was illuminated by a faint light, equally dispersed, as in the case of the preceding plate. But being received at the distance of 13 feet from the plate, six small black streaks began to be visible, as in fig. 6. At 17 feet from the plate, the black streaks were broader, more distinct, and more separated from the streaks that were less dark. At 42 feet from the plate, only two

black streaks were seen in the middle of the penumbra, as in fig. 7. This middle penumbra between the two black streaks was tinged with red. Next to the black streaks there always appeared the streaks of light, which were broad, and the coloured streaks next to them.

Receiving the shadow of the same plate at the distance of 72 feet, the appearances were the same as in the former situation, except that the two black streaks were broader, and the interval between them, occupied by the penumbra, was broader also, and tinged with a deeper red.

In the same rays of the sun he placed different plates, and larger than the former, one of them a line and a half, another two lines, another three lines broad, &c. but receiving their shadows upon paper, he could not perceive in them those streaks of faint light which he had observed in the shadows of the small plates, though he received these shadows at the distance of 56 feet. Nothing was seen but a weak light, equally diffused, as in the shadows of the two smallest plates, received very near them. But had his dark chamber been large enough, he did not doubt, but that, at a proper distance, there would have been the same appearances in the shadows of the larger plates as in those of the smallest. For the same reason, he supposed, that, if the shadows of the small needles could have been distinctly viewed very near those bodies, the different streaks of light and shade would have been as visible in them as in those of the small plates; and indeed he did observe the same appearances in the shadows of needles of a middling size.

The streaks of light in these shadows our author ascribed to the rays of light which are reflected at different distances from the bodies; and he imagined that their crossing one another was sufficient to account for the variations observable in them at different distances.

The extraordinary size of the shadows of these small substances M. Maraldi thought to be occasioned by the shadow from the enlightened part of the sky, added to that which was made by the light of the sun, and also to a vortex occasioned by the circulation of the reflected light behind the object; but our readers will probably not think it necessary for us either to produce all his reasons for this hypothesis, or to enter into a refutation of them.

Our author having made the preceding experiments upon single long substances, had the curiosity to place two of them so as to cross one another in a beam of the sun's light. The shadows of two hairs placed in this manner, and received at some distance from them, appeared to be painted reciprocally one upon the other, so that the obscure part of one of them was visible upon the obscure part of the other. The streaks of light also crossed one another, and the coloured streaks did the same.

Having placed a needle and a hair crossing one another, their shadows, at the same distance, exhibited the same appearances as the shadows of the two hairs, though the shadow of the needle was the stronger.

He also placed in the rays of the sun a bristle and a plate of iron a line thick, so that they crossed one another:

another obliquely; and when their shadows were received at the same distance, the light and dark streaks of the shadow of the bristle were visible so far as the middle of the shadow of the plate on the side of the acute angle, but not on the side of the obtuse angle, whether the bristle or the plate were placed next to the rays. The plate made a shadow sufficiently dark, divided into six black streaks; and these were again divided by as many light ones equal to them; and yet all the streaks belonging to the shadow of the bristles were visible upon it, as in fig. 8. To explain this appearance, he supposed that the rays of the sun slid a little along the bristle, so as to enlighten part of that which is behind the plate. But this seems to be an arbitrary and improbable supposition.

Our philosopher did not fail to expose several small globes in the light of the sun in his dark chamber, and to compare their shadows with those of the long substances, as he had done in the day-light, and the appearances were still similar. It was particularly evident, that there was much more light in the shadows of the globes than in those of the cylinders, not only when they were both of an equal diameter, but when that of the globe was larger than that of the cylinder, and the shadows of both the bodies were received at the same distance. He also observed, that he could perceive no difference of light in the shadows of the plates which were a little more than one line broad, though they were received at the distance of 72 feet; but he could easily see a difference of shades in those of the globes, taken at the same distance, tho' they were 2½ lines in diameter.

In order to explain the colours at the edges of these shadows, he contrived to throw some of the shadows upon others; and the following observations, though they did not enable him to accomplish what he intended, are curious and worth reciting.

57  
Experiments with  
a mixture  
of coloured  
shadows.

Having thrown several of the similar colours upon one another, and thereby produced a tinge more lively than before, he threw the gleam of light, which always intervened between the colours and the darker part of the shadow, upon different parts of other shadows; and observed, that, when it fell upon the exterior penumbra made by another needle, it produced a beautiful sky-blue colour, almost like that which was produced by two blue colours thrown together. When the same gleam of light fell upon the deeper shadow in the middle, it produced a red colour; which seemed to prove, that the reddish colour in the middle of several of the shadows might come from the little light infected into that place. But here our author seems to have been misled by some false hypothesis concerning colours.

He placed two plates of iron, each three or four lines broad, very near one another, but with a very small interval between them; and having placed them in the rays of the sun, and received their shadows at the distance of 15 or 20 feet from them, he saw no light between them but a continued shadow, in the middle of which were some streaks of a lively purple, parallel to one another, and separated by other black streaks; but between them there were other streaks, both of a very faint green, and also of a pale yellow. He also informs us, that M. Delisle had observed co-

lours in the streaks of light and shade, which are observable in shadows taken near the bodies.

Among those who followed Sir Isaac Newton in his observations on the inflection of light, we also find the ingenious M. Mairan; but, without attempting the discovery of new facts, he only endeavoured to explain the old ones, by the hypothesis of an atmosphere surrounding all bodies; and consequently making two reflections and refractions of the light that impinges upon them, one at the surface of the atmosphere, and the other at that of the body itself. This atmosphere he supposed to be of a variable density and refractive power, like the air.

M. Mairan was succeeded by M. Du Tour, who thought the variable atmosphere superfluous, and imagined that he could account for all the phenomena by the help of an atmosphere of a uniform density, and of a less refractive power than the air surrounding all bodies. But what we are most obliged to this gentleman for is, not his ingenious hypothesis, but the beautiful variety with which he has exhibited the experiments, which will render it much easier for any person to investigate the true causes of them.

Before M. Du Tour gave his attention to this subject, only three fringes had been observed in the colours produced by the inflection of light; but he was accidentally led to observe a greater number of them, and hit upon the following ingenious method of making them all appear very distinct.

He took a circular board ABED (fig. 9.), 13 inches in diameter, the surface of which was black, except at the edge, where there was a ring of white paper about three lines broad, in order to trace the circumference of a circle, divided into 360 degrees, beginning at the point A, and reckoning 180 degrees on each hand to the point E; B and D being each of them placed at 90 degrees. A slip of parchment three inches broad, and disposed in the form of a hoop, was fastened round the board, and pierced at the point E with a square hole, each side being four or five lines, in order to introduce a ray of the sun's light. Lastly, in the centre of the board C, and perpendicular to it, he fixed a pin about ¼ of a line in diameter.

Plate  
CCVII.

This hoop being so disposed, that a ray of light entering the dark chamber, through a vertical cleft of two lines and a half in length, and about as wide as the diameter of the pin, went through the hole at E, and passing parallel to the plane of the board, projected the image of the sun and the shadow of the pin at A. In these circumstances he observed,

1. That quite round the concave surface of this hoop, there were a multitude of coloured streaks; but that the space  $m A n$ , of about 18 degrees, the middle of which was occupied by the image of the sun, was covered with a faint light only.

2. The order of the colours in these streaks was generally such that the most refrangible rays were the nearest to the incident ray ECA; so that, beginning from the point A, the violet was the first, and the red the last colour in each of the streaks. In some of them, however, the colours were disposed in a contrary order.

3. The image of the sun, projected on each side of the point A, was divided by the shadow of the pin, which was bordered by two luminous streaks.

4. The coloured streaks were narrower in some parts of the hoop than others, and generally decreased in breadth in receding from the point A.

5. Among these coloured streaks, there were sometimes others which were white, a line or a line and an half in breadth, which were always bordered on both sides by a streak of orange colour, at least when the light of the sun was intense, and the chamber sufficiently dark.

From this experiment he thought it was evident, that the rays which passed beyond the pin were not the only ones that were decomposed, for that those which are reflected back from the pin were decomposed also; from which he concluded, that they must have undergone some refraction. He also thought that those which went beyond the pin suffered a reflection, so that they were all affected in a similar manner.

In order to account for these facts, our author describes the progress of a ray of light through an uniform atmosphere, which he supposes to surround the pin; and shews, that the differently refrangible rays will be separated at their emergence from it: but he refers to some experiments and observations in a future memoir, to demonstrate that all the coloured streaks are produced by rays that are both reflected and refracted.

To give some idea of his hypothesis, he shews that the ray  $a b$ , fig. 10. after being refracted at  $b$ , reflected at  $r$  and  $u$ , and again refracted at  $v$  and  $t$ , will be divided into its proper colours; the least refrangible or the red rays issuing at  $x$ , and the most refrangible or violet at  $y$ ; which agrees with his observations. Those streaks in which the colours appear in a contrary order he thinks are to be ascribed to inequalities in the surface of the pin. This might easily have been ascertained by turning the pin round, in which case these differently-coloured streaks would have changed their places.

If any person should choose to repeat these experiments, he observes that it requires that the sky be very clear and free from vapours, in order to exhibit the colours with the greatest distinctness; since even the vapours that are imperceptible, will diminish the lustre of the colours on every part of the hoop, and even efface some of them, especially those which are on that in which the beam of light enters, as at E, where the colours are always fainter than in any other place, and indeed can never be distinguished except when the hole E is confined by black substances, so as to intercept a part of the light that might reach the pin; and unless also those rays which go beyond the pin to form the image of the sun at A be stopped, so that no rays are visible except those that are reflected towards the hole, and which make the faint streaks.

The coloured streaks that are next the shadow of the pin, he shews, are formed by those rays which, entering the atmosphere, do not fall upon the pin; and, without any reflection, are only refracted at their entering and leaving the atmosphere, as at  $b$  and  $r u$ , fig. 11. In this case, the red or least refrangible rays will issue at  $r$ , and the violet at  $u$ .

To distinguish the rays which fell upon the hoop in any particular direction, from those that came in any other, he made an opening in the hoop, as at P,

by which means he could, with advantage, and at any distance from the centre, observe those rays unmixed with any other.

To account for the coloured streaks being larger next the shadow of the pin, and growing narrower to the place where the light was admitted, he shews, by fig. 12. that the rays  $a b$  are farther separated by both the refractions than the rays  $c d$ .

Sometimes our author observed, that the broader streaks were not disposed in this regular order; but then he found, that, by turning the pin, they changed their places, so that this circumstance must have been an irregularity depending upon the accidental surface of the pin.

The white streaks intermixed with the coloured ones he ascribes to small cavities in the surface of the pin, or some other foreign circumstance; for they also changed their places when the pin was made to turn upon its axis.

Other observations of our author seem to prove that the refracting atmospheres surrounding all kinds of bodies are of the same size; for when he placed a great variety of substances, and of different sizes also, he always found the coloured streaks of the same dimensions.

M. Du Tour observes that his hypothesis contradicts an observation of Sir Isaac Newton, that those rays which pass the nearest to any body are the most inflected; but he thinks that Newton's observations were not sufficiently accurate. Besides, he observes, that Newton only said that *he thought it to be so*, without asserting it positively.

Since the rays which formed these coloured streaks are but little diverted out of their way, our author infers that this atmosphere is of small extent, and that its refractive power is not much less than that of air.

Exposing two pieces of paper in the beam of light, so that part of it passed between two planes formed by them, M. Du Tour observed, that the edges of this light, received upon paper, were bordered with two orange-coloured streaks, which Newton had not taken notice of in any of his experiments. To account for them, he supposes, that in fig. 13. the more refrangible of the rays which enter at  $b$  are so refracted, that they do not reach the surface of the body itself at R; so that the red and orange-coloured light may be reflected from thence in the direction  $d M$ , where the orange-coloured streak will be formed; and, for the same reason, another streak of orange will be formed at  $m$ , by the rays which enter the atmosphere on the other side of the chink. In a similar manner he accounts for the orange-coloured fringes at the borders of the white streaks, in the experiment of the hoop.

The blue rays, which are not reflected at R, he supposes pass on to I, and that of these rays the blue tinge observable in the shadows of some bodies are formed.

M. Le Cat has well explained a phenomenon of vision depending upon the inflection of light, which shews, that, in some cases, objects appear magnified by this means. Looking at a distant object, when a wire, of a less diameter than the pupil of his eye, was held pretty near to it, and drawing it several times

betwixt

Plate  
CCVII.

60

Account of  
Du Tour's  
hypothesis.

61

Objects sometimes magnified by the inflection of light.

betwixt his eye and that object, he was surpris'd to find, that, every time the wire pass'd before his pupil, the spectacle seem'd to change its place, and some hills beyond the spectacle seem'd to have the same motion, just as if a lens had been drawn betwixt his eye and them.

Examining this appearance more attentively, he found that there was a position of the wire, but very difficult to keep, in which the spectacle seem'd not to have any motion, when the wire was pass'd before his eye; and in this case the spectacle appear'd less distinctly, and seem'd to be magnified. These effects being similar to those of a lens, he attend'd to them more particularly; and plac'd his eye in such a manner, with respect to the spectacle, that the rays of light by which he saw it must come very close to the edge of a window, where he had plac'd himself to make his observations. Then pass'd the wire once more before his eye, he observ'd, that, when it was in the visual axis, the spectacle appear'd nearer to the window, on whichever side the wire was made to approach. He repeated this experiment, and constantly with the same result, the object being always magnified, and nearly doubled, by this means.

This phenomenon is easily explain'd by fig. 14. in which B represents the eye, A the spectacle, and C the diameter of the wire. The black lines express the cone of light by which the natural image of the spectacle A is form'd, and which is much narrower than the diameter of the wire C; but the dotted lines include not only that cone of light, stopp'd and turn'd out of its course by the wire, but also more distant rays intersected by the wire, and thereby thrown more converging into the pupil; just as would have been the effect of the interposition of a lens between the eye and the object. The result of this experiment was the same, whatever substances he made use of in the place of the wire, provided they were of the same diameter.

This discovery, depending upon the inflection of the rays of light, led him to several others depending upon the same principle. Thus he magnified small objects, as the head of a pin, by looking at them through a small hole in a card; so that the rays which form'd the image must necessarily pass so near the circumference of the hole, as to be attracted by it. He also observ'd, that, by bringing his finger near the cone of light, which transmitt'd to him the image of any object well insulafed, as a red coal in the midst of cinders, or a black coal in the midst of the fire, the object seem'd to stretch itself towards his finger, as it approach'd, and to follow it to a certain distance when it was withdrawn. He thought it was owing to the same cause, that the clouds which pass over the face of the sun occasion various motions in the shadow of bodies; and when these clouds are interrupted in different places, those shadows seem to dance, which is particularly visible in the shadows made by the leads in glass-windows. It was to the same inflection of light that he ascrib'd, in part, the prismatic colours which he saw by the means of a very fine pin, plac'd near to his eye, and on which he made the light of a candle to fall obliquely.

##### § 5. Discoveries concerning Vision.

MAUROLYCUS was the first who shew'd the true

theory of vision, by demonstrat'g that the crystalline humour of the eye is a lens which collects the light issuing from external objects, and throws them upon the retina, where is the focus of each pencil. He did not, however, find out, that, by means of this refraction of the rays, an image of every visible object was form'd upon the retina, though this seems hardly to have been a step beyond the discovery he had already made. Montucla conjectures, that he was prevented from coming to this difficulty of accounting for the upright appearance of objects, as this image is always inverted. This discovery was made by Kepler; but he, too, was much difficulted with the inverted position of the image. The rectification of these images, he says, is the business of the mind; which, when it perceives an impression on the lower part of the retina, considers it as made by rays proceeding from the higher parts of objects; tracing the rays back to the pupil, where they cross one another. But this hypothesis can scarcely be deem'd satisfactory.—Kepler did not pretend to account for the manner in which the mind perceives the images upon the retina, and very much blames Vitellio for attempting prematurely to determine a question of this nature, and which indeed, he says, does not belong to optics. He accounts, however, though not in a satisfactory manner, for the power we have of seeing distinctly at different distances.

The discovery concerning vision was completed by Scheiner. For, in cutting away the coats of the back part of the eyes of sheep and oxen, and presenting several objects before them, within the usual distance of vision, he saw their images distinctly and beautifully painted upon the retina. He did the same thing with the human eye, and exhibit'd this curious experiment at Rome in 1625. He takes particular notice of the resemblance between the eye and the camera obscura, and explains a variety of methods to make the images of objects erect. As to the images of objects being inverted in the eye, he acquiesces in the reason given for it by Kepler. He knew that the pupil of the eye is enlarg'd in order to view remote objects, and that it is contract'd while we are viewing those that are near; and this he prov'd by experiment, and illustrat'd by figures.

Scheiner also took a good deal of pains to ascertain the density and refractive power of all the humours of the eye by comparing their magnifying power with that of water or glass in the same form and circumstances. The result of his inquiries was, that the aqueous humour doth not differ much from water in this respect, nor the crystalline from glass; and that the vitreous humour is a medium between both. He also very accurately and minutely traces the progress of the rays of light through all the humours of the eye, and after discussing every possible hypothesis concerning the proper seat of vision, he demonstrates that it is in the retina, and shews that this was the opinion of Alhazen, Vitellio, Kepler, and all the most eminent philosophers. He produces many reasons of his own for this hypothesis; answers a great number of objections to it; and, by a variety of arguments, refutes the opinion of former times, that the seat of vision is in the crystalline.

Descartes makes a good number of observations on the

Discoveries  
of Mauro-  
lycus, Kep-  
&c.  
concerning  
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Discoveries  
of Schei-  
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62  
Miscellane-  
ous observa-  
tions.

<sup>65</sup>  
Discoveries  
of De-  
vices.

the phenomena of vision. He explains satisfactorily the natural methods of judging of the magnitudes, situations and distances, of objects by the direction of the optic axes; comparing it to a blind man's judging of the size and distance of an object, by feeling at it with two sticks of a known length, when the hands in which he holds them are at a known distance from each other. He also observes, that having been accustomed to judge of the situation of objects by their images falling on a particular part of the eye; if by any distortion of the eye they fall on a different place, we are apt to mistake their situation, or imagine one object to be two; as, till we become accustomed to it, we imagine one stick to be two, when it is placed between two contiguous fingers laid across one another. But he observes, that all the methods we have of judging of the distances of objects are very uncertain, and extend but to narrow limits. The direction of the optic axes, he says, will not serve us beyond 15 or 20 feet, and the change of form of the crystalline not more than three or four feet. For he imagined that the eye conforms itself to the view of near or distant objects by a change in the curvature of the crystalline, which he supposed to be a muscle, the tendons of it being the processus ciliares. In another place, he says, that the change in the conformation of the eye is of no use to us for the purpose of judging of distances beyond four or five feet, and the angle of the optic axes not more than 100 or 200 feet. For this reason, he says, that the sun and moon are conceived to be much more nearly of the same size than they are in reality. White and luminous objects, he says, appear larger than others, and also the parts contiguous to those on which the rays actually impinge; and for the same reason, if the objects be small, and placed at a great distance, they will always appear round, the figure of the angles disappearing. The description of the eye itself, the various modes of vision and optical deceptions to which we are liable, being properly to the succeeding part of this treatise.

§ 6. *Of Optical Instruments, and Discoveries concerning them.*

<sup>66</sup>  
Invention of spec-  
tacles.

So little were the ancients acquainted with the science of Optics, that they seem to have had no instruments of the optical kind, excepting the glass globes and speculums formerly mentioned, which they used in some cases for magnifying and burning. Alhazen, as we have seen, gave the first hint of the invention of spectacles, and it is probable that they were found out soon after his time. From the writings of Alhazen and the observations and experiments of Bacon together, it is not improbable that some monks gradually hit upon the construction of spectacles; to which Bacon's lesser segment, notwithstanding his mistake concerning it, was a nearer approach than Alhazen's larger one. Whoever they were that pursued the discoveries of Bacon, they probably observed, that a very small convex glass, when held at a greater distance from the book, would magnify the letters more than when it was placed close to them, in which position only Bacon seems to have used it. In the next place, they might try whether two of these small segments of a sphere placed together, or a glass con-

vex on both sides, would not magnify more than one of them. They would then find, that two of these glasses, one for each eye, would answer the purpose of reading better than one; and lastly they might find, that different degrees of convexity suited different persons.

It is certain that spectacles were well known in the 13th century, and not long before. It is said that Alexander Spina, a native of Pisa, who died in 1313, and who was very ingenious in executing whatever he saw or heard of as having been done by others, happened to see a pair of spectacles in the hands of a person who would not explain them to him; but that he succeeded in making a pair for himself, and immediately made the construction public, for the good of others. It is also inscribed on the tomb of Salvinus Armatus, a nobleman of Florence, who died 1317, that he was the inventor of spectacles.

The use of concave glasses, to help those persons <sup>67</sup>Of concave who are short-sighted, was, probably, a discovery glasses. that did not follow long after that of convex ones, for the relief of those whose sight is defective in the contrary extreme, though we find no trace of this improvement. Whoever made this discovery, it was probably the result of nothing more than a random experiment. Perhaps a person who was short-sighted, finding that convex glasses did him more harm than good, had the curiosity to make trial of a contrary curvature of the glass.

From this time, though both convex and concave <sup>68</sup>Descartes's lenses were sufficiently common, yet no attempt was account of made to form a telescope by a combination of them, the inven- tion of tele- scopes. till the end of the 16th century. Descartes considers James Metius, a person who was no mathematician, though his father and brother had applied to those sciences, as the first constructor of a telescope; and says, that as he was amusing himself with making mirrors and burning-glasses, he casually thought of looking thro' two of his lenses at a time; and that happening to take one that was convex and another that was concave, and happening also to hit upon a pretty good adjustment of them, he found, that, by looking thro' them, distant objects appeared very large and distinct. In fact, without knowing it, he had made a telescope.

Other persons say, that this great discovery was first <sup>69</sup>Other ac- made by John Lippertheim, a maker of spectacles at counts. Middleburgh, or rather by his children; who, like, Metius, were diverting themselves with looking thro' two glasses at a time, and placing them at different distances from one another. But Borellus, the author of a book intitled, *De vero telescopii inventore*, gives this honour to Zacharias Joannides, i. e. Janfen, another maker of spectacles at the same place, who made the first telescope in 1590; and it seems now to be the general opinion, that this account of Borellus is the most probable.

Indeed, Borellus's account of the discovery of tele- <sup>70</sup>Borellus's scopes is so circumstantial, and so well authenticated, account that it does not seem possible to call it in question. It probably is not true, he says, that this great discovery was made by a person who was no philosopher: for Zacharias Janfen was a diligent inquirer into nature; and being engaged in these pursuits, he was trying what uses could be made of lenses for those purposes, when he



he fortunately hit upon the construction.

This ingenious mechanic, or rather philosopher, had no sooner found the arrangement of glasses that produced the effect he desired, than he inclosed them in a tube, and ran with his instrument to prince Maurice; who immediately conceiving that it might be of use to him in his wars, desired the author to keep it a secret. But this, though attempted for some time, was found to be impossible; and several persons in that city immediately applied themselves to the making and selling of telescopes. One of the most distinguished of these was Hans Laprey, called *Lipperheim* by Sirturus. By him some person in Holland being very early supplied with a telescope, he passed with many for the inventor; but both Metius above-mentioned, and Cornelius Drebell of Alcmar, in Holland, applied to the inventor himself in 1620; as also did Galileo, and many others. The first telescope made by Janfen did not exceed 15 or 16 inches in length; but Sirturus, who says that he had seen it, and made use of it, thought it the best that he had ever examined.

Janfen, having a philosophical turn, presently applied his instrument to such purposes as he had in view when he hit upon the construction. Directing it towards celestial objects, he distinctly viewed the spots on the surface of the moon; and discovered many new stars, particularly seven pretty considerable ones in the great bear. His son Joannes Zacchariz, noted the lucid circle near the limb of the moon, from whence several bright rays seem to dart in different directions; and he says, that the full moon viewed through this instrument, did not appear flat, but was evidently spherical, the middle part being prominent. Jupiter also, he says, appeared round, and rather spherical; and sometimes he perceived two, sometimes three, and at the most four small stars, a little above or below him; and as far as he could observe, they performed revolutions round him; but this, he says, he leaves to the consideration of astronomers. This, it is probable, was the first observation of the satellites of Jupiter, tho' the person who made it was not aware of the importance of his discovery.

One Francis Fontana, an Italian, also claims the invention; but as he did not pretend to have made it before the year 1608, and as it is well known that the instruments were made and sold in Holland some time before, his pretensions to a second discovery are not much regarded.

There are some, who say that Galileo was the inventor of telescopes; but he himself acknowledges, that he first heard of the instrument from a German; but he says, that being informed of nothing more than the effects of it, first by common report, and a few days after by a French nobleman, J. Badovere, at Paris, he himself discovered the construction, by considering the nature of refraction: and thus he had much more real merit than the inventor himself.

The account of what Galileo actually did in this business, is so circumstantially related by the author of his life, prefixed to the quarto edition of his works, printed at Venice in 1744, and it contains so many particulars, which cannot but be pleasing to every person who is interested in the history of telescopes, that we shall abridge a part of it, intermixing circumstances collected from other accounts.

About April or May, in 1609, it was reported at Venice, where Galileo (who was professor of mathematics in the university of Padua) then happened to be, that a Dutchman had presented to Count Maurice of Nassau, a certain optical instrument, by means of which, distant objects appeared as if they were near; but no farther account of the discovery had reached that place, tho' this was near 20 years after the first discovery. Struck, however, with this account, Galileo instantly returned to Padua, considering what kind of an instrument this must be. The night following, the construction occurred to him; and the day after, putting the parts of the instrument together, as he had previously conceived of it, and notwithstanding the imperfection of the glasses that he could then procure, the effect answered his expectations, as he presently acquainted his friends at Venice; to which place, he six days afterwards carried another and a better instrument that he had made, and where, from several eminences, he shewed to some of the principal senators of that republic a variety of distant objects, to their very great astonishment. When he had made farther improvements in the instrument, he, with his usual generosity and frankness in communicating his discoveries, made a present of one of them to the Doge, Leonardo Donati, and at the same time to all the senate of Venice; giving along with the instrument, a written paper, in which he explained the structure and wonderful uses that might be made of it both by land and at sea. In return for so noble an entertainment, the republic, on the 25th of August, in the same year, more than tripled his salary as professor.

Our philosopher, having amused himself for some time with the view of terrestrial objects, at length directed his tube towards the heavens; and, observing the moon, he found, that the surface of it was diversified with hills and valleys, like the earth. He found that the *via lactea* and *nebulae* consisted of a collection of fixed stars, which, on account either of their vast distance, or extreme smallness, were invisible to the naked eye. He also discovered innumerable fixed stars dispersed over the face of the heavens, which had been unknown to all the ancients; and examining Jupiter, with a better instrument than any he had made before, he found that he was accompanied by four stars, which, in certain fixed periods, performed revolutions round him, and which, in honour of the house of Medici, he called *Medicean planets*.

This discovery he made in January 1610, new style; and continuing his observations the whole of February following, in the beginning of March next he published an account of all his discoveries, in his *Nuncius Sidericus*, printed at Venice, and dedicated to Cosimo, great duke of Tuscany, who, by a letter which he wrote to him on the 10th of July 1610, invited him to quit Padua, and assigned him an ample stipend, as primate and extraordinary professor at Pisa, but without any obligation to read lectures, or to reside.

The extraordinary discoveries contained in the *Nuncius Sidericus*, which was immediately reprinted both in Germany and France, was the cause of much speculation and debate among the philosophers and astronomer's of that time; many of whom could not be brought

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73  
A telescope  
made by  
Galileo  
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seeing one.

brought to give any credit to Galileo's account, while others endeavoured to decry his discoveries as being nothing more than fictions or illusions. Some could not be prevailed upon even to look through a telescope; so devoted were they to the system of Aristotle, and so averse to admit any other source of knowledge besides his writings. When it was found to be in vain to oppose the evidence of sense, some did not scruple to assert that the invention was taken from Aristotle; and producing a passage from his writings, in which he attempts to give a reason why stars are seen in the day-time from the bottom of a deep well, said, that the well corresponded to the tube of the telescope, and that the vapours which arose from it gave the hint of putting glasses into it; and lastly, that in both cases the sight is strengthened by the transmission of the rays through a thick and dark medium. Galileo himself tells this story with a great deal of humour; comparing such men to alchymists, who imagine that the art of making gold was known to the ancients, but lay concealed under the fables of the poets.

In the beginning of July of the same year, 1610, Galileo being still at Padua, and getting an imperfect view of Saturn's ring, imagined that that planet consisted of three parts; and therefore, in the account which he gave of this discovery to his friends, he calls it *planetam tergeminum*.

Whilst he was still at Padua, which must have been either in the same month of July, or the beginning of August following, he observed some spots on the face of the sun; but, contrary to his usual custom, he did not choose, at that time, to publish his discovery; partly for fear of incurring more of the hatred of many obdurate peripatetics; and partly, in order to make more exact observations on this remarkable phenomenon, and to form some conjecture concerning the probable cause of it. He therefore contented himself with communicating his observations to some of his friends at Padua and Venice, among whom we find the name of father Paul. This delay, however, was the cause of this discovery being contested with him by the famous Scheiner, who likewise made the same observation in Oct. 1611, and we suppose had anticipated Galileo in the publication of it.

About the end of August, Galileo left Padua and went to Florence; and in November following he was satisfied, that, from the September preceding, Venus had been continually increasing in bulk, and that she changed her phases like the moon. About the end of March 1611, Galileo went to Rome, where he gratified the cardinals, and all the principal nobility, with a view of the new wonders he had discovered in the heavens, and among others the solar spots.

From these discoveries Galileo obtained the name of *Linceus*, who was famous in antiquity for the acuteness of his sight; and moreover, the marquis of Monticelli instituted an academy, with the title of *De' Lincei*, and made him a member of it. Twenty-nine years Galileo enjoyed the use of his telescope, continually enriching astronomy with his observations: but by too close an application to that instrument, and the detriment he received from the nocturnal air, his eyes grew gradually weaker, till in 1639 he became totally blind; a calamity which, however, neither broke his spirits, nor interrupted the course of his studies.

The first telescope that Galileo constructed magnified only three times; but presently after, he made another which magnified 18 times: and afterwards, with great trouble and expence, he constructed one that magnified 33 times; and with this it was that he discovered the satellites of Jupiter, and the spots of the sun.

Notwithstanding Galileo must be allowed to have considerable merit with respect to telescopes, it was neither that of the person who first hit upon the construction, nor that of him who thoroughly explained the *rationalis* of the instrument. This important service to science was performed by John Kepler, whose name is famous on many accounts in the annals of philosophy, and especially by his discovery of the great law of motion respecting the heavenly bodies; which is, that the squares of their periodical times are as the cubes of their distances from the body about which they revolve; a proposition which, however, was not demonstrated before Sir Isaac Newton. Kepler was astronomer to several of the emperors of Germany; he was the associate of the celebrated astronomer Tycho Brahe, and the master of Descartes.

Kepler made several discoveries relating to the nature of vision; and not only explained the rationale of the telescope which he found in use, but also pointed out methods of constructing others of superior powers and more commodious application.

It was Kepler who first gave a clear explication of the effects of lenses, in making the rays of a pencil of light converge or diverge. He shewed, that a plano-convex lens makes rays that were parallel to its axis, to meet at the distance of the diameter of the sphere of convexity; but that if both sides of the lens be equally convex, the rays will have their focus at the distance of the radius of the circle, corresponding to that degree of convexity. But he did not investigate any rule for the foci of lenses unequally convex. He only says, in general, that they will fall somewhere in the medium, between the foci belonging to the two different degrees of convexity. It is to Cavalleri that we owe this investigation. He laid down this rule: As the sum of both the diameters is to one of them, so is the other to the distance of the focus. All these rules concerning convex lenses are applicable to those that are concave; with this difference, that the focus is on the contrary side of the glass, as will be particularly shewn in the second part of this treatise.

The principal effects of telescopes depend upon these plain maxims, viz. That objects appear larger in proportion to the angles which they subtend at the eye; and the effect is the same whether the pencils of rays, by which objects are visible to us, come directly from the objects themselves, or from any place nearer to the eye, where they may have been united so as to form an image of the object; because they issue again from those points where there is no real substance, in certain directions, in the same manner as they did from the corresponding points in the objects themselves.

In fact, therefore, all that is effected by a telescope is, first to make such an image of a distant object, by means of a lens or mirror; and then to give the eye some assistance for viewing that image as near as possible; so that the angle which it shall subtend at the eye, may be very large compared with the angle which the

76  
Account  
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scopes.

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the effects  
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scopes.

75  
Name of Linceus from this.

the object itself would subtend in the same situation. This is done by means of an eye-glass, which refracts the pencils of rays, as that they may afterwards be brought to their several foci by the natural humours of the eye. But if the eye was so formed as to be able to see the image with sufficient distinctness at the same distance without any eye-glass, it would appear to him as much magnified as it does to another person who makes use of a glass for that purpose, though he would not in all cases have so large a field of view.

If, instead of an eye-glass, an object, or the image of an object, be looked at thro' a small hole in a thin plate or piece of paper, held close to the eye, it may be viewed very near to the eye, and at the same distance, the apparent magnitude of the object will be the same in both cases. For if the hole be so small as to admit but a single ray from every distinct point of the object, these rays will fall upon the retina in as many other distinct points, and make a distinct image. They are only pencils or cones of rays, which have a sensible base, as the breadth of the pupil, that are capable, by their spreading on the retina, of producing an indistinct image. As very few rays, however, can be admitted through a small hole, there will seldom be light sufficient to view any object to advantage in this manner.

If no image be actually formed by the foci of the pencils without the eye, yet, if, by the help of any eye-glass, the pencils of rays shall enter the pupil, just as they would have done from any place without the eye, the visual angle will be the same as if an image had actually been formed in that place. Objects will not appear inverted through this telescope, because the pencils which form the images of them, only cross one another once, viz. at the object-glass, as in natural vision they do in the pupil of the eye.

79  
Galilean telescope more difficult of construction than others

Such is the telescope that was first discovered and used by philosophers; and it is remarkable that it should be of a much more difficult construction than some other kinds that have been invented since. The great inconvenience attending it is, that the field of view is exceedingly small. For since the pencils of rays enter the eye very much diverging from one another, but few of them can be intercepted by the pupil; and this inconvenience increases with the magnifying power of the telescope; so that philosophers at this day cannot help wondering, that it was possible, with such an instrument, for Galileo and others to have made the discoveries they did. It must have required incredible patience and address. No other telescope, however, than this, was so much as thought of for many years after the discovery. Descartes, who wrote 30 years after, mentions no other as actually constructed, though Kepler had suggested some.

80  
Telescopes improved by Kepler.

It is to this great man that we are indebted for the construction of what we now call the *astronomical telescope*, being the best adapted for the purpose of viewing the heavenly bodies. The *rationale* of this instrument is explained, and the advantages of it are clearly pointed out, by this philosopher, in his *Catoptrics*; but, what is very surprising, he never actually reduced his excellent theory into practice. Montucla conjectures, that the reason why he did not make trial of his new construction was, his not being aware of the great increase of the field of view; so that being engaged in other pursuits, he might not think it of much consequence

Vol. VII.

1

to take any pains about the construction of an instrument, which could do little more than answer the same purpose with those of which he was already possessed. He must also have foreseen, that the length of this telescope must have been greater in proportion to its magnifying power; so that it might appear to him to be upon the whole not quite so good a construction as the former.

81  
His method first put in practice by Scheiner.

It was not long, however, before Kepler's new scheme of a telescope was executed; and the first person who actually made an instrument of this construction, was Father Scheiner, who has given a description of it in his *Rosa Ursina*, published in 1630. It, says he, you insert two similar lenses (that is, both convex) in a tube, and place your eye at a convenient distance, you will see all terrestrial objects inverted, indeed, but magnified and very distinct, with a considerable extent of view. He afterwards subjoins an account of a telescope of a different construction, with two convex eye-glasses, which again reverses the images, and makes them appear in their natural position. This disposition of the lenses had also been pointed out by Kepler, but had not been reduced to practice by him, any more than the former. This construction, however, answered the end but very imperfectly; and Father Rheita presently after hit upon a better construction, using three eye-glasses instead of two. This got the name of the *terrestrial telescope*, being chiefly used for terrestrial objects.

The first and last of these constructions are those which are now in common use. The proportion in which the first telescope magnifies, is as the focal length of the object-glass to that of the eye-glass.—The only difference between the Galilean telescope and the other is, that the pencils by which the extremities of any object are seen in this case, enter the eye diverging; whereas, in the other, they enter it converging; but if the sphere of concavity in the eye-glass of the Galilean telescope be equal to the sphere of convexity in the eye-glass of another telescope, their magnifying power will be the same. The concave eye-glass, however, being placed between the object-glass and its focus, the Galilean telescope will be shorter than the other, by twice the focal length of the eye-glass. Consequently, if the length of the telescopes be the same, the Galilean will have the greater magnifying power.

82  
Vision most owing perhaps, in part, to there being no intermediate image between the eye and the object. Besides, the Galilean telescopes.

Vision is also more distinct in these telescopes; owing perhaps, in part, to there being no intermediate image between the eye and the object. Besides, the eye-glass being very thin in the centre, the rays will be less liable to be distorted by irregularities in the substance of the glass. Whatever be the cause, we can sometimes see Jupiter's satellites very clearly in a Galilean telescope not more than twenty inches or two feet long; when one of four or five feet, of the common sort, will hardly make them visible.

83  
The same Father Rheita, to whom we are indebted for the useful construction of a telescope for land-objects, invented a binocular telescope, which Father Cherubin, of Orleans, endeavoured to bring into use afterwards. It consists of two telescopes fastened together, and made to point to the same object. When this instrument is well fixed, the object appears larger, and nearer to the eye, when it is seen through both

31 D

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the telescopes, than through one of them only, tho' they have the very same magnifying power. But this is only an illusion, occasioned by the stronger impression that two equal images, equally illuminated, make upon the eye. This advantage, however, is counterbalanced by the inconvenience attending the use of it.

84  
Telescopes  
of Campani  
and Divini.

The first who distinguished themselves in grinding telescope glasses were two Italians, Eustachio Divini at Rome, and Campani at Bologna, whose fame was much superior to that of Divini, or that of any other person of his time; though Divini himself pretended, that, in all the trials that were made with their glasses, his, of a great focal distance, performed better than those of Campani, and that his rival was not willing to try them fairly, viz. with equal eye-glasses. It is generally supposed, however, that Campani really excelled Divini, both in the goodness and the focal length of his object-glasses. It was with telescopes made by Campani that Cassini discovered the nearest satellites of Saturn. They were made by the express order of Lewis XIV. and were of 86, 100, and 136 Parisian feet focal length.

Campani sold his lenses for a great price, and took every possible method to keep his art of making them a secret. His laboratory was inaccessible to all the world, till after his death; when it was purchased by Pope Benedict XIV. who made a present of it to the academy called the *Institute*, established in that city; and by the account which M. Foucheroux has given of what he could discover from it, we learn, that (except a machine, which M. Campani constructed, to work the basons on which he ground his glasses) the goodness of his lenses depended upon the clearness of his glass, his Venetian tripoli, the paper with which he polished his glasses, and his great skill and address as a workman. It was also the general opinion at Bologna, that he owed a great part of his reputation to the secrecy and air of mystery which he affected; and that he made a great number of object-glasses which he rejected, shewing only those that were very good. He made few lenses of a very great focal distance; and having the misfortune to break one of 141 feet in two pieces, he took incredible pains to join the two parts together, which he did at length effectually, so that it was used as if it had been entire; but it is not probable that he would have taken so much pains about it, if, as he pretended, he could very easily have made another as good.

Sir Paul Neille, Dr Hooke says, made telescopes of 36 feet, pretty good, and one of 50, but not of proportional goodness. Afterwards Mr Reive first, and then Mr Cox, who were the most celebrated in England as grinders of optic glasses, made some good ones of 50 and 60 feet focal distance, and Mr Cox made one of 100; but how good, Dr Hooke could not assert.

Borelli, also, in France made object-glasses of a great focal length, one of which he presented to the royal society; but we do not find any particular account of their goodness.

85  
Extraordi-  
nary object-  
glasses made  
by Mr  
Auzout.

With respect to the focal length of telescopes, these and all others were far exceeded by M. Auzout, who made one object-glass of 600 feet focus; but he was never able to manage it, so as to make any use of it. Hartsocker is even said to have made some of a still

greater focal length; but this ingenious mechanic, finding it impossible to make use of object-glasses, the focal distance of which was much less than this, when they were inclosed in a tube, contrived a method of using them without a tube, by fixing them at the top of a tree, a high wall, or the roof of a house.

Mr Huygens, who was also an excellent mechanic, made considerable improvements in the method of using an object-glass without a tube. He placed it at the top of a very long pole, having previously inclosed it in a short tube, which was made to turn in all directions, by means of a ball and socket. The axis of this tube he could command with a fine silk string, so as to bring it into a line with the axis of another short tube, which he held in his hand, and which contained the eye-glass. In this method he could make use of object-glasses of the greatest magnifying power, at whatever altitude his object was, and even in the zenith, provided his pole was as long as his telescope; and, to adapt it to the view of objects of different altitudes, he had a contrivance, by which he could raise or depress a stage that supported his object-glass at pleasure.

M. De la Hire made some improvement in this method of managing the object-glass, fixing it in the centre of a board, and not in a tube; but as it is not probable that this method will ever be made use of, since the discovery of both reflecting and achromatic telescopes, which are now brought to great perfection, and have even micrometers adapted to them, we shall not describe this apparatus minutely; but shall only give a drawing of M. Huygens's pole, which, with a very short explanation, will be sufficient for the purpose. In fig. 1. *a* represents a pulley, by the help of which a stage *c, d, e, f*, (that supports the object-glass *k*, and the apparatus belonging to it) may be raised higher or lower at pleasure, the whole being counterpoised by the weight *h*, fastened to a string *g*. *n*, is a weight, by means of which the centre of gravity of the apparatus belonging to the object-glass is kept in the ball and socket, so that it may be easily managed by the string *l, u*, and its axis brought into a line with the eye-glass at *a*. When it was very dark, M. Huygens was obliged to make his object-glass visible by a lantern, *y*, so constructed as to throw the rays of light in a parallel direction up to it.

The recollection of the incredible pains which philosophers of the last age took in making observations, and the great expences they were obliged to be at for that purpose, should make us sensible of the obligations we are under to such men as Gregory, Newton, and Dollond, who have enabled us to get clearer and more satisfactory views of the remote parts of our system, with much less labour and expence; and should likewise make us more diligent and solicitous to derive all the advantages we possibly can from such capital improvements.

The reason why it is necessary to make the common dioptric telescopes so very long, is, that the length of them must be increased in no less a proportion than the duplicate of the increase of their magnifying power; so that, in order to magnify twice as much as before, with the same light and distinctness, the telescope must be lengthened four times; and

86  
Telescopes  
fixed with-  
out tubes.

Plate  
CCVIII.

87  
Why diop-  
tric tele-  
scopes must  
be made so  
long.

to

Fig. 1.

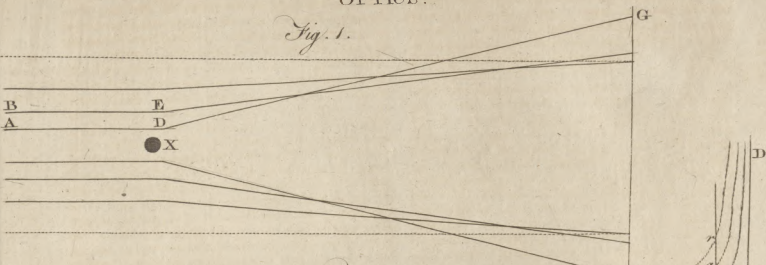


Fig. 2.

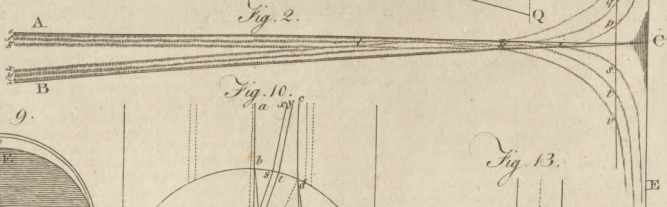


Fig. 9.

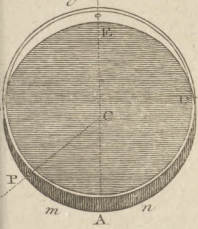


Fig. 10.

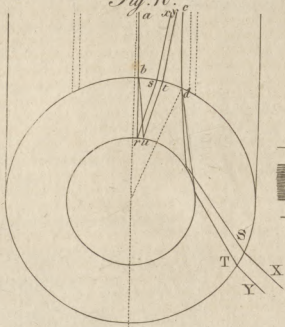


Fig. 13.

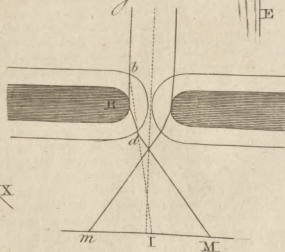


Fig. 11.

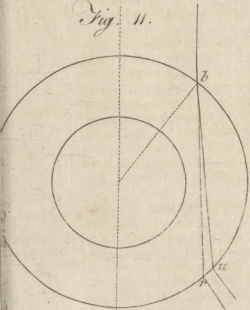


Fig. 12.

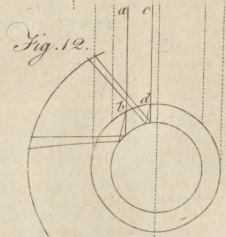


Fig. 3.



Fig. 4.



Fig. 5.



Fig. 6.



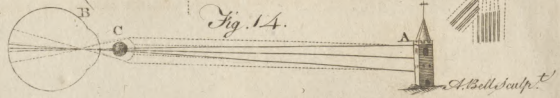
Fig. 7.



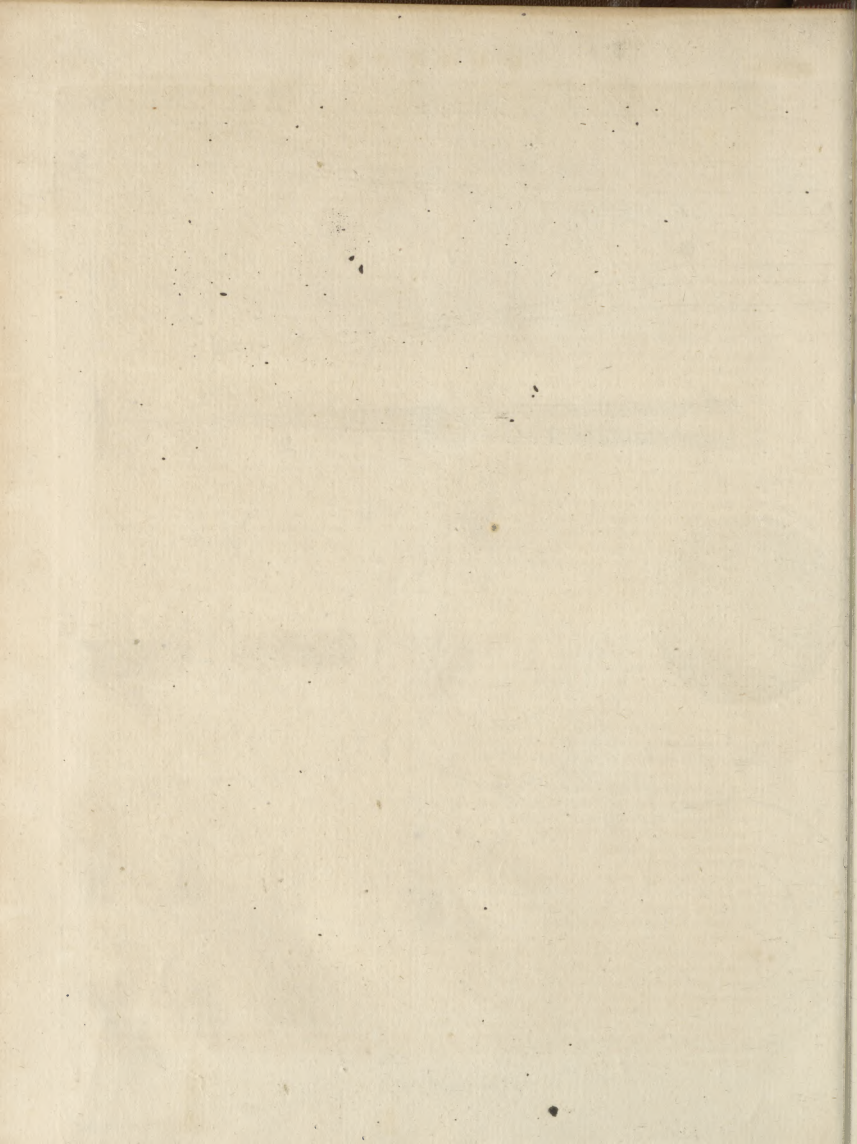
Fig. 8.



Fig. 14.



A. Bell's sculp. t.



88  
Of the aper-  
tures of re-  
fracting te-  
lescopes.

to magnify thrice as much, nine times; and so on. Before we mention the *reflecting telescope*, it must be observed, that M. Auzout, in a paper delivered to the Royal Society, observed, that the apertures which the object-glasses of refracting telescopes can bear with distinctness, are in about a sub-duplicate proportion to their lengths; and upon this supposition he drew up a table of the apertures proper for object-glasses of a great variety of focal lengths, from 4 inches to 400 feet. Upon this occasion, however, Dr Hooke observed, that the same glass will bear a greater or less aperture, according to the less or greater light of the object. If, for instance, he was viewing the sun, or Venus, or any of the fixed stars, he used smaller apertures: but if he wanted to view the moon by daylight; or Saturn, Jupiter, or Mars, by night; he used a larger aperture.

But the merit of all these improvements was in a manner cancelled by the discovery of the much more commodious *reflecting telescope*. For a refracting telescope, even of 1000 feet focus, supposing it possible to be made use of, could not be made to magnify with distinctness more than 1000 times; whereas a reflecting telescope, not exceeding 9 or 10 feet, will magnify 1200 times.

89  
History of  
the reflect-  
ing tele-  
scope.

“It must be acknowledged, (says Dr Smith in his *Complete System of Optics*), that Mr James Gregory of Aberdeen was the first inventor of the reflecting telescope; but his construction is quite different from Sir Isaac Newton’s, and not nearly so advantageous.”

But, according to Dr Pringle, Merfennus was the man who entertained the first thought of a reflector. A telescope with specula he certainly proposed to the celebrated Descartes many years before Gregory’s invention, though indeed in a manner so very unsatisfactory, that Descartes, who had given particular attention to the improvement of the telescope, was so far from approving the proposal, that he endeavoured to convince Merfennus of its fallacy (A). Dr Smith, it appears, had never perused the two letters of Descartes to Merfennus which briefly touch on that subject.

Again, as to his assertion, that Gregory’s construction was not nearly so advantageous as Newton’s, it may be accounted for from his having set it down early in the composition of his work, and forgetting to qualify it afterwards, when, before the publication, he had received pretty sure information to the contrary. Or perhaps he was influenced by the example of Dr Bradley, who had been a most successful observer, and yet had always preferred the Newtonian telescope to the other. But we must certainly adjudge the superiority to the latter, as that is now, and has been for several years past, the only instrument of the kind in request.

Gregory, a young man of an uncommon genius, was led to the invention, in seeking to correct two imperfections of the common telescope: the first was its too great length, which made it less manageable; the second, the incorrectness of the image. Mathematicians had demonstrated, that a pencil of rays could not be collected in a single point by a spherical lens;

2

and also, that the image transmitted by such a lens would be in some degree incurvated. These inconveniences he believed would be obviated by substituting for the object-glass a metallic speculum, of a parabolic figure, to receive the image, and to reflect it towards a small speculum of the same metal: this again was to return the image to an eye-glass placed behind the great speculum, which for that purpose was to be perforated in its centre. This construction he published in 1663, in his *Optica Promota*. But as Gregory, as he himself declares, was endowed with no mechanical dexterity, nor could find any workman capable of realizing his invention, after some fruitless attempts in that way he was obliged to give up the pursuit: and probably, had not some new discoveries been made in light and colours, a reflecting telescope would never more have been thought of, considering the difficulty of the execution, and the small advantages that could accrue from it, deducible from the principles of optics that were then known.

But Newton, whose happy genius for experimental knowledge was equal to that for geometry, happily interposed, and saved this noble invention from well-nigh perishing in its infant-state. He likewise at an early period of life had applied himself to the improvement of the telescope; but imagining that Gregory’s specula were neither very necessary, nor likely to be executed, he began with prosecuting the views of Descartes, who aimed at making a more perfect image of an object, by grinding lenses, not to the figure of a sphere, but to that of one of the conic sections. Now, whilst he was thus employed, three years after Gregory’s publication, he happened to take to the examination of the colours formed by a prism, and having by the means of that simple instrument discovered the different refrangibility of the rays of light, he then perceived that the errors of telescopes, arising from that cause alone, were some hundred times greater than such as were occasioned by the spherical figure of lenses. This circumstance, forced, as it were, Newton to fall into Gregory’s track, and to turn his thoughts to reflectors. “The different refrangibility of the rays of light (says he, in a letter to Mr Oldenburg, secretary to the Royal Society, dated in Feb. 1672), made me take reflections into consideration; and finding them regular, so that the angle of reflection of all sorts of rays was equal to the angle of incidence, I understood, that by their mediation optic instruments might be brought to any degree of perfection imaginable, providing a reflecting substance could be found which would polish as finely as glass, and reflect as much light as glass transmits, and the art of communicating to it a parabolic figure be also obtained. Amidst these thoughts I was forced from Cambridge by the intervening plague, and it was more than two years before I proceeded further.”

It appears, then, that if Newton was not the first inventor of the reflecting telescope, he was the main and effectual inventor. By the force of his admirable genius, he fell upon this new property of light; and thereby found, that all lenses, of whatever figure, would be affected more or less with such prismatic aberrations

31 D 2

of

(A) *Lettres de Descartes, tome ii.* printed at Paris in 1657, lett. 29. and 32. See this point discussed by two learned and candid authors, M. le Roi in the *Encyclopedie*, under the article *Telescope*, and M. Montecula in *Hist. des Mathemat. tome ii.* p. 644.

of the rays as would be an insuperable obstacle to the perfection of a dioptric telescope.

It was towards the end of 1668, or in the beginning of the following year, when Newton, being thus obliged to have recourse to reflectors, and not relying on any artificer for making his specula, set about the work himself, and early in the year 1672 completed two small reflecting telescopes. In these he ground the great speculum into a spherical concave; not but that he approved of the parabolic form proposed by Gregory, though he found himself unable to accomplish it. In the letter that accompanied one of these instruments which he presented to the Society, he writes, "that though he then despaired of performing that work (to wit, the parabolic figure of the great speculum) by geometrical rules, yet he doubted not but that the thing might in some measure be accomplished by mechanical devices."

Not less did the difficulty appear to find a metallic substance that would be of a proper hardness, have the fewest pores, and receive the smoothest polish: a difficulty in truth which he deemed almost unmountable, when he considered, that every irregularity in a reflecting surface would make the rays of light stray five or six times more out of their due course, than the like irregularities in a refracting one. In another letter, written soon after, he tells the secretary, "that he was very sensible that metal reflects less light than glass transmits; but as he had found some metallic substances to be more strongly reflective than others, to polish better, and to be freer from tarnishing than others, so he hoped that there might in time be found out some substances much freer from these inconveniences than any yet known." Newton therefore laboured till he found a composition that answered in some degree, and left it to those who should come after him to find a better, and presented a reflecting telescope to the Royal Society; from whom he received such thanks as were due to so curious and valuable a present. And Huygens, one of the greatest geniuses of the age, and himself a distinguished improver of the refractor, no sooner was informed by Mr Oldenburg of the discovery, than he wrote in answer, "that it was an admirable telescope; and that Mr Newton had well considered the advantage which a concave speculum had above convex glasses in collecting the parallel rays, which according to his own calculation was very great: Hence that Mr Newton could give a far greater aperture to that speculum than to an object-glass of the same distance of focus, and consequently much more magnify in his way than by an ordinary telescope: Besides, that by the reflector he avoided an inconvenience inseparable from object-glasses, which was the obliquity of both their surfaces, which vitiated the refraction of the rays that pass towards the sides of the glass, and did more hurt than men were aware of: Again, that by the mere reflection of the metalline speculum there were not so many rays lost as in glasses, which reflected a considerable quantity by each of their surfaces, and besides intercepted many of them by the absurdity of their matter: That the main business would be, to find a matter for this speculum that would bear as good and even a polish as glass. Lastly, he believed that Mr Newton had not been without considering the advantage which

a parabolic speculum would have over a spherical one in this construction; but had despaired, as he himself had done, of working other surfaces than spherical ones with due exactness." Huygens was not satisfied with thus expressing to the society his high approbation of the late invention; but drew up a favourable account of the new telescope, which he caused to be published in the *Journal des Savans* for the year 1672, and by that channel it was soon known over Europe.

But how excellent soever the contrivance was; how well soever supported and announced to the public; yet whether it was that the artists were deterred by the difficulty and labour of the work, or that the discoveries even of a Newton were not to be exempted from the general fatality attending great and useful inventions, *the making a slow and vexatious progress to the authors*; the fact is, that, excepting an unsuccessful attempt which the society made, by employing an artificer to imitate the Newtonian construction, but upon a larger scale, and a disguised Gregorian telescope, set up by Cassiegrain abroad as a rival to Newton's, and that in theory only (for it never was put in execution by the author), no reflector was heard of for nearly half a century after. But when that period was elapsed, a reflecting telescope was at last produced to the world of the Newtonian construction by Dr Hadley, which the author had the satisfaction to find executed in such a manner as left no room to fear that the invention would any longer continue in obscurity.

This memorable event was owing to the genius, dexterity, and application, of Mr Hadley the inventor of the reflecting quadrant, another most valuable instrument. The two telescopes which Newton had made were but six inches long, were held in the hand for viewing objects, and in power were compared to a six-foot refractor; whereas Hadley's was above five feet long, was provided with a well-contrived apparatus for managing it, and equalled in performance the famous aerial telescope of Huygens of 123 feet in length. Excepting as to the manner of making the specula, we have, in the transactions of 1723, a complete description, with a figure, of this telescope, together with that of the machine for moving it; but, by a strange omission, Newton's name is not once mentioned in that paper, so that any person not acquainted with the history of the invention, and reading that account only, might be apt to conclude that Hadley had been the sole contriver of it.

The same celebrated artist, after finishing two telescopes of the Newtonian construction, accomplished a third in the Gregorian way; but, it would seem, less successfully, by Dr Smith's declaring so strongly in favour of the other. Mr Hadley spared no pains to instruct Mr Molyneux and the reverend Dr Bradley; and when those gentlemen had made a sufficient proficiency in the art, being desirous that these telescopes should become more public, they liberally communicated to some of the principal instrument-makers of London the knowledge they had acquired from him. Now such scholars, as it is easy to imagine, soon advanced beyond their masters, and completed reflectors by other and better methods than what had been taught them.



Certain it is, at least, that Mr James Short, as early as the year 1734, had signalized himself at Edinburgh by his work of this kind. Mr Maclaurin wrote that year to Dr Jurin, "that Mr Short, who had begun with making glass specula, was then applying himself to improve the metallic; and that, by taking care of the figure, he was enabled to give them larger apertures than others had done; and that upon the whole they surpassed in perfection all that he had seen of other workmen." He added, "that Mr Short's telescopes were all of the Gregorian construction; and that he had much improved that excellent invention." This character of excellence Mr Short maintained to the last; and with the more facility, as he had been well grounded both in the geometrical and philosophical principles of optics, and upon the whole was a most intelligent person in whatever related to his profession. It was supposed he had fallen upon a method of giving the parabolic figure to his great speculum; a point of perfection that Gregory and Newton had wished for, but despaired of attaining; and that Hadley had never, as far as we know, attempted, either in his Newtonian or Gregorian telescope. Mr Short indeed said he had acquired that faculty, but never would tell by what peculiar means he effected it; so that the secret of working that configuration, whatever it was, as far as it then appeared, died with that ingenious artist. Mr Mudge, however, hath lately realized the expectation of Sir Isaac Newton, who, above 100 years ago, professed that the public would one day possess a parabolic speculum, not accomplished by mathematical rules, but by mechanical devices.

This was a desideratum, but it was not the only want supplied by this gentleman: he has taught us likewise a better composition of metals for the specula, how to grind them better, and how to give them a finer polish; and this last part, (namely, the polish), he remarks, was the most difficult and essential of the whole operation. "In a word, (says Sir John Pringle), I am of opinion, there is no optician in this great city (which hath been so long and so justly renowned for ingenious and dextrous makers of every kind of mathematical instruments) so partial to his own abilities as not to acknowledge, that, however some parts of the mechanical process now disclosed might have been known before by individuals of the profession, yet that Mr Mudge hath opened to them all some new and important lights, and upon the whole hath greatly improved the art of making reflecting telescopes."

The greatest improvement in *refracting* telescopes is that of Mr Dollond, of which an account has already been given in a preceding section, wherein his discoveries in the science of Optics were explained. But, besides the obligation we are under to him for correcting the aberration of the rays of light in the focus of object-glasses, arising from their different refrangibility, he made another considerable improvement in telescopes, viz. by correcting, in a great measure, both this kind of aberration, and also that which arises from the spherical form of lenses, by an expedient of a very different nature; viz. increasing the number of eye-glasses.

If any person, says he, would have the visual angle

of a telescope to contain 20 degrees, the extreme pencils of the field must be bent or refracted in an angle of 10 degrees; which, if it be performed by one eye-glass, will cause an aberration from the figure, in proportion to the cube of that angle; but if two glasses are so proportioned and situated, as that the refraction may be equally divided between them, they will each of them produce a refraction equal to half the required angle; and therefore, the aberration being in proportion to the cube of half the angle taken twice over, will be but a fourth part of that which is in proportion to the cube of the whole angle; because twice the cube of 1 is but  $\frac{1}{4}$  of the cube of 2; so the aberration from the figure, where two eye-glasses are rightly proportioned, is but a fourth of what it mult unavoidably be where the whole is performed by a single eye-glass. By the same way of reasoning, when the refraction is divided between three glasses, the aberration will be found to be but the ninth part of what would be produced from a single glass; because three times the cube of 1 is but one-ninth of the cube of 3. Whence it appears, that by increasing the number of eye-glasses, the indistinctness which is observed near the borders of the field of a telescope may be very much diminished, though not entirely taken away.

The method of correcting the errors arising from the different refrangibility of light is of a different consideration from the former. For, whereas the errors from the figure can only be diminished in a certain proportion according to the number of glasses, in this they may be entirely corrected by the addition of only one glass; as we find in the astronomical telescope, that two eye-glasses, rightly proportioned, will cause the edges of objects to appear free from colours, quite to the borders of the field. Also in the day-telescope, where no more than two eye-glasses are absolutely necessary for erecting the object, we find, that by the addition of a third, rightly situated, the colours, which would otherwise make the image confused, are entirely removed. This, however, is to be understood with some limitation: for though the different colours into which the extreme pencils must necessarily be divided by the edges of the eye-glasses, may in this manner be brought to the eye in a direction parallel to each other, so as, by the humours of the eye, to be made to converge to a point on the retina; yet, if the glasses exceed a certain length, the colours may be spread too wide, to be capable of being admitted thro' the pupil or aperture of the eye; which is the reason, that in long telescopes, constructed in the common manner, with three eye-glasses, the field is always very much contracted.

These considerations first set Mr Dollond on contriving how to enlarge the field, by increasing the number of eye-glasses without any hindrance to the distinctness or brightness of the image; and though others had been about the same work before, yet, observing that some five-glass telescopes which were then made would admit of farther improvement, he endeavoured to construct one with the same number of glasses in a better manner; which he far answered his expectations, as to be allowed by the best judges to be a considerable improvement on the former.

Encouraged by this success, he resolved to try if he could:

could not make some farther enlargement of the field, by the addition of another glass, and by placing and proportioning the glasses in such a manner as to correct the aberrations as much as possible, without any detriment to the distinctness; and at last he obtained as large a field as is convenient or necessary, and that even in the longest telescopes that can be made.

These telescopes with six glasses having been well received, and some of them being gone into foreign parts, it seemed a proper time to the author to settle the date of his invention; on which account he drew up a letter, which he addressed to Mr Short, and which was read at the Royal Society, March 1, 1753.

<sup>91</sup>  
Mr Smith's  
proposal to  
shorten tele-  
scopes.

Various other attempts were made about this time to shorten and otherwise improve telescopes. Among these we must just mention that of Mr Caleb Smith, who, after giving much attention to the subject, thought that he had found it possible to rectify the errors which arise from the different degrees of refrangibility, on the principle that the sines of refraction, or rays differently refrangible, are to one another in a given proportion, when their sines of incidence are equal; and the method which he proposed for this purpose was to make the speculums of glass instead of metal, the two surfaces having different degrees of concavity. But we do not find that his scheme was ever executed; nor is it probable, for reasons which have been mentioned, that any advantage could be made of it.

<sup>92</sup>  
Equatorial  
telescope,  
or portable  
observatory

To Mr Short we are indebted for the excellent contrivance of an equatorial telescope, or, as he likewise called it, a *portable observatory*; for with it pretty accurate observations may be made with very little trouble, by those who have no building adapted to the purpose. The instrument consists of an ingenious piece of machinery, by the help of which a telescope mounted upon it may be directed to any degree of right ascension or declination, so that the place of any of the heavenly bodies being known, they may be found without any trouble, even in the day-time. Also, being made to turn parallel to the equator, any object is easily kept in view, or recovered, without moving the eye from its situation. By this instrument, Mr Short informs us, that most of the stars of the first and second magnitude have been seen even at mid-day, and the sun shining bright; as also Mercury, Venus, and Jupiter. Saturn and Mars are not so easy to be seen, on account of the faintness of their light, except when the sun is but a few hours above the horizon. This particular effect depends upon the telescope excluding almost all the light, except what comes from the object itself, and which might otherwise efface the impression made by its weaker light upon the eye. Any telescope of the same magnifying power would have the same effect, could we be sure of pointing it right. For the same reason, also, it is that stars are visible in the day-time from the bottom of a deep pit.

<sup>93</sup>  
How to ob-  
serve the  
stars in the  
day-time.

In order to enable us to see the fixed stars in the day-time, it is necessary to exclude the extraneous light as much as possible. For this reason the greater magnifying power of any telescope is used, the more easily a fixed star will be distinguished in the day-time; the light of the star remaining the same in all magnifying powers of the same telescope, but the ground upon which it is seen becoming darker by increasing

the magnifying power; and the visibility of a star depends very much upon the difference between its own light and that of the ground upon which it is seen. A fixed star will be very nearly equally visible with telescopes of very different apertures, provided the magnifying power remains the same.

If a comet, or any other heavenly body, be viewed through this equatorial telescope, properly rectified, it is seen immediately by the help of the same machinery what is its true place in the heavens. Other astronomical problems may also be solved by it, with great ease and certainty. But a particular description of its construction and uses, will be afterwards given.

M. Äpinus proposes to bend the tubes of long telescopes at right angles, fixing a plane mirror in the angle, in order to make them more commodious for viewing objects near the zenith of the observer; and thus he gives particular instructions how to make them in this form, especially when they are furnished with micrometers. We are also informed that a little plane speculum is sometimes placed betwixt the last eye-glass and the eye in the reflecting telescopes, at an angle of 45°, for the same purpose.

<sup>94</sup>  
Mr Epi-  
nus's pro-  
posal for  
bending the  
tubes of te-  
lescopes.

The invention of *Microscopes* was not much later than that of telescopes; and, according to Borellus, whose account we do not find to have been called in question by any person, we are indebted for them to the same author, at least to Z. Janfen, in conjunction with his son; and for this latter favour we may, perhaps, be considered as under more obligation to them than for the former, the microscope having more various and extensive uses, with respect to philosophy, than the telescope. In our ideas, however, it appears something greater, and more extraordinary, to be able to see objects too distant to be perceived by the naked eye, than those that are too near to be seen by us; and therefore there is more of the sublime in the telescope than the microscope. These two instruments, though different in their application, are notwithstanding very similar; as both of them assist us in the discovery of objects that we must otherwise have remained unacquainted with, by enlarging the angle which they subtend at the eye.

<sup>95</sup>  
History of  
microscopes

The Janfens, however, have not always enjoyed, undisturbed, that share of reputation to which they seem to be intitled, with respect either to the telescope or the microscope. The discovery of the latter, in particular, has generally been considered as more uncertain than that of the former. All that many writers say we can depend upon is, that microscopes were first used in Germany about the year 1621. Others say positively, that this instrument was the contrivance of Cornelius Drebell, no philosopher, but a man of curiosity and ingenuity, who also invented the thermometer.

According to Borellus, Zacharias Janfen and his son presented the first microscopes they had constructed to prince Maurice, and Albert archduke of Austria. William Borell, who gives this account in a letter to his brother Peter, says, that when he was ambassador in England, in 1619, Cornelius Drebell, with whom he was intimately acquainted, shewed him a microscope, which he said was the same the archduke had given him, and had been made by Janfen himself.

This

This instrument was not so short as they are generally made at present, but was six feet long, consisting of a tube of gilt copper, an inch in diameter, supported by three brass pillars in the shape of dolphins, on a base of ebony, on which the small objects were placed.

<sup>96</sup>  
Microscope  
made by  
Janfen.

This telescope was evidently a compound one, or rather something betwixt a telescope and a microscope, what we should now, perhaps, choose to call a *megaloscope*; so that it is possible that single microscopes might have been known, and in use, some time before: but perhaps nobody thought of giving that name to single lenses; though, from the first use of lenses, they could not but have been used for the purpose of magnifying small objects. In this sense we have seen, that even the ancients were in possession of microscopes; and it appears from Jamblicus and Plutarch, quoted by Dr Rogers, that they gave such instruments as they used for this purpose the name of *dioptra*. As spectacles were certainly in use long before the invention of telescopes, one can hardly help concluding, that lenses must have been made smaller, and more convex, for the purpose of magnifying of minute objects; especially as the application of this kind of microscope was nearly the same with that of a spectacle glass, both of them being held close to the eye. At what time lenses were made so small as we now generally use them for magnifying in single microscopes, we have not found. But as this must necessarily have been done gradually, the only proper object of inquiry is the invention of the double, or compound microscope; and this is clearly given, by the evidence of Borellus above-mentioned, to Zacharias Janfen, the inventor of the telescope, or his son.

The invention of compound microscopes is claimed by the same Fontana who claimed the discovery of telescopes; and though he did not publish any account of this improvement till the year 1646 (notwithstanding he pretended to have made the discovery in 1618), Montucla, not having attended perhaps to the testimony of Borellus, is willing to allow his claim, as he thought there was no other person who seemed to have any better right to it.

<sup>97</sup>  
By Divini.

Eustachio Divini made microscopes with two common object-glasses, and two plano-convex eye-glasses joined together on their convex sides so as to meet in a point. The tube in which they were inclosed was as big as a man's leg, and the eye-glasses almost as broad as the palm of a man's hand. Mr Oldenburg, secretary to the royal society, received an account of this instrument from Rome, and read it at one of their meetings, August 6, 1668.

<sup>98</sup>  
By Hart-  
socker.

It was in this period that Hartsocker improved single microscopes, by using small globules of glass, made by melting them in the flame of a candle, instead of the lenses which had before been made use of for that purpose. By this means he first discovered the *animalcula in semine masculino*, which gave rise to a new system of generation. A microscope of this kind, consisting of a globule of  $\frac{1}{12}$  of an inch in diameter, M. Huygens demonstrated to magnify 100 times; and since it is easy to make them of less than half a line in diameter, they may be made to magnify 300 times. Were it not for the difficulty of applying objects to these magnifiers, the want of light, and the small field of distinct vision, they would certainly have been the

most perfect of all microscopes.

But no man distinguished himself so much by microscopical discoveries as the famous M. Leeuwenhoek, <sup>99</sup> by Leeuwenhoek. though he used only single lenses with short foci, preferring distinctness of vision to a large magnifying power.

M. Leeuwenhoek's microscopes were all single ones, each of them consisting of a small double convex-glass, set in a socket between two silver plates rivetted together, and pierced with a small hole; and the object was placed on the point of a needle, so contrived, as to be placed at any distance from the lens. If the objects were solid, he fastened them with glue; and if they were fluid, or on other accounts required to be spread upon glass, he placed them on a small piece of Muscovy talc, or glass blown very thin; which he afterwards glued to his needle. He had, however, a different apparatus for viewing the circulation of the blood, which he could fix to the same microscopes.

The greatest part of his microscopes M. Leeuwenhoek bequeathed to the royal society. They were contained in a small Indian cabinet, in the drawers of which were 13 little boxes, or cases, in each of which were two microscopes, neatly fitted up in silver; and both the glass and the apparatus were made with his own hands.

The glass of all these lenses is exceedingly clear, but none of them magnifies so much as those globules which are frequently used in other microscopes; but Mr Folkes, who examined them, thought that they shewed objects with much greater distinctness, which M. Leeuwenhoek principally valued. His discoveries, however, are to be ascribed not so much to the goodness of his glasses, as to his great judgment, acquired by long experience, in using them. He also particularly excelled in his manner of preparing objects for being viewed to the most advantage.

Mr Baker, who also examined M. Leeuwenhoek's microscopes, and made a report concerning them to the royal society, found that the greatest magnifier among them enlarged the diameter of an object about 160 times, but that all the rest fell much short of that power; so he concluded that M. Leeuwenhoek must have had other microscopes of a much greater magnifying power for many of his discoveries. And it appears, he says, by many circumstances, that he had such microscopes.

It appears from M. Leeuwenhoek's writings, that he was not unacquainted with the method of viewing opaque objects by means of a small concave reflecting mirror, which was afterwards improved by M. Lieberkühn. For, after describing his apparatus for viewing eels in glass tubes, he adds, that he had an instrument to which he screwed a microscope set in brass, upon which microscope he fastened a little dish of brass, probably that his eye might be thereby assisted to see objects better; for he says he had filed the brass which was round his microscope as bright as he could, that the light, while he was viewing objects, might be reflected from it as much as possible. This microscope, with its dish, (of which an exact copy, taken from the picture in his works, may be seen, Plate CCVIII. fig. 2.) seems so like our opaque microscope, with its silver speculum, that it may well be supposed to have given the hint to the ingenious inven-

ventor of it, provided he ever attended to it.

<sup>100</sup>  
Wilson's  
microscope.

In 1702, Mr Wilson made several ingenious improvements in the method of using single magnifiers, for the purpose of viewing transparent objects; and they have been generally approved, that hardly any other method is made use of at this day. The capital advantage attending this microscope consists in its being furnished with a pretty large lens, to throw light upon the objects, and also with a fine screw and spring, to bring them nearer, or remove them farther from the magnifier at pleasure. This microscope is also a necessary part of the solar microscope, invented afterwards.

<sup>101</sup>  
Adams's  
method of  
making glo-  
bules for  
large mag-  
nifiers.

In 1710, Mr Adams gave to the Royal Society the following account of his method of making small globules for large magnifiers. He took a piece of fine window-glass, and cut it with a diamond into as many lengths as he thought proper, not exceeding  $\frac{1}{8}$  of an inch in breadth; then, holding one of them between the fore-finger and thumb of each hand over a very fine flame, till the glass began to soften, he drew it out till it was as fine as a hair, and broke; then putting each of the ends into the purest part of the flame, he had two globules presently, which he could make larger or less at pleasure. If they were held a long time in the flame, they would have spots in them, so that he drew them out presently after they became round. The stem he broke off as near to the globule as he could, and lodging the remainder between the plates, in which holes were drilled exactly round, the microscope, he says, performed to admiration. Through these magnifiers, he says, that the same thread of very fine muslin appeared three or four times bigger than it did in the largest of Mr Wilson's magnifiers.

<sup>102</sup>  
Temporary  
microscopes  
by Mr  
Grey.

The ingenious Mr Grey hit upon a very easy expedient to make very good temporary microscopes, at a very little expence. They consist of nothing but very small drops of water, taken up with a point of a pin, and put into a small hole made in a piece of metal. These globules of water do not, indeed, magnify so much as those which are made of glass of the same size, because the refractive power of water is not so great; but the same purpose will be answered nearly as well by making them somewhat smaller.

The same ingenious person, observing that small heterogeneous particles inclosed in the glass of which microscopes are made, were much magnified when those glasses were looked through, thought of making his microscopes of water that contained living animalcula, to see how they would look in this new situation; and he found his scheme to answer even beyond his utmost expectation, so that he could not even account for their being magnified so much as they were: for it was much more than they would have been magnified if they had been placed beyond the globule, in the proper place for viewing objects. But Montucla observes, that, when any object is inclosed within this small transparent globule, the hinder-part of it acts like a concave mirror, provided they be situated between that surface and the focus; and that, by this means, they are magnified above  $3\frac{1}{2}$  times more than they would have been in the usual way.

After the happy execution of the reflecting telescope, it was natural to expect that attempts would also be made to render a similar service to microscopes. Accordingly

we find two plans of this kind. The first was that of Dr Robert Barker. His instrument differs in nothing from the reflecting telescope, excepting the distance of the two speculums, in order to adapt it to those pencils of rays which enter the telescope diverging; whereas they come from very distant objects nearly parallel to each other.

This microscope is not so easy to manage as the common sort. For vision by reflection, as it is much more perfect, so it is far more difficult than that by refraction. Nor is this microscope so useful for any but very small or transparent objects. For the object, being between the speculum and image, would, if it were large and opaque, prevent a due reflection.

In Dr Smith's reflecting microscope there are two reflecting mirrors, one concave and the other convex, and the image is viewed by a lens.

This microscope, though far from being executed in the best manner, performed, Dr Smith says, nearly as well as the very best refracting microscopes; so that he did not doubt but that it would have excelled them, if it had been executed properly. Dr Smith's own account of this instrument may be seen in his Optics, Remarks, p. 94.

In 1738 or 1739, M. Lieberkuhn made two capital improvements in microscopes, by the invention of the solar microscope, and the microscope for opaque objects.

When he was in England in the winter of 1739, he shewed an apparatus of his own making, for each of these purposes, to several gentlemen of the Royal Society, as well as to some opticians, particularly Mr Cuff in Fleet-street, who took great pains to improve them.

The solar microscope, as made by Mr Cuff, was composed of a tube, a looking-glass, a convex lens, and a Wilson's microscope. Of this, and of another constructed by Mr Martin, a particular description will be afterwards given.

The microscope for opaque objects remedies the inconvenience of having the dark side of an object next the eye. For by means of a concave speculum of silver, highly polished, in the centre of which a magnifying lens is placed, the object is so strongly illuminated that it may be examined with all imaginable ease and pleasure. A convenient apparatus of this kind, with four different speculums and magnifiers of different powers, was brought to perfection by Mr Cuff.

M. Lieberkuhn made considerable improvements in his solar microscope, particularly in adapting it to the view of opaque objects; but in what manner this end was effected, M. Äpinus, who was highly entertained with the performance, and who mentions the fact, was not able to recollect; and the death of the ingenious inventor prevented his publishing any account of it himself. M. Äpinus invites those persons who came into the possession of M. Lieberkuhn's apparatus to publish an account of this instrument; but it doth not appear that his method was ever published.

This improvement of M. Lieberkuhn's induced M. Äpinus himself to attend to the subject; and by this means produced a very valuable improvement in this instrument. For by throwing the light upon the fore-side of any object by means of a mirror, before it is transmitted through the object-lens, all kinds of objects are equally well represented by it.

M.

106  
Reflected  
light intro-  
duced into  
the micro-  
scope and  
magic lan-  
tern.

M. Euler proposed a scheme to introduce vision by reflected light into the magic lantern and solar microscope, by which many inconveniences to which those instruments are subject, might be avoided. For this purpose, he says, that nothing is necessary but a large concave mirror, perforated as for a telescope; and that the light be so situated, that none of it may pass directly through the perforation, so as to fall on the images of the objects upon the screen. He proposes to have four different machines, for objects of different sizes; the first for those of six feet long, the second for those of one foot, the third for those of two inches, and the fourth for those of two lines. An idea of this contrivance is given in Plate CCVIII. fig. 3. in which OD represents the concave mirror, E the object, *l, l* the lights, and A the lens, through which the rays are transmitted to the screen.

Several improvements were made in the apparatus to the solar microscope, as adapted to view opaque objects, by M. Zeiher, who made one construction for the larger kind of objects, and another for the small ones.

107  
Mr Martin's  
improvement  
in the solar  
microscope.

Mr Martin having constructed a solar microscope of a larger size than common, for his own use, the illuminating lens being  $4\frac{1}{2}$  inches in diameter, and all the other parts of the instrument in proportion, found, that by the help of an additional part, which he does not describe, he could see even opaque objects very well. If he had made the lens any larger, he was aware that the heat produced at the focus would be too great for the generality of objects to bear. The expence of this instrument, he says, does not much exceed the price of the common solar microscope.

108  
Di Torres's  
extraordi-  
nary mag-  
nifying mi-  
croscope.

The smallest globules, and consequently the greatest magnifiers, for microscopes, that have yet been executed, were made by T. Di Torre of Naples, who, in 1765, sent four of them to the Royal Society. The largest of them was only two Paris points in diameter, and it was said to magnify the diameter of an object

640 times. The second was the size of one Paris point, and the third was no more than half of a Paris point, or the 144th part of an inch in diameter, and was said to magnify the diameter of an object 2560 times. One of these globules was wanting when they came into the hands of Mr Baker, to whose examination they were referred by the Royal Society. This gentleman, so famous for his skill in microscopes, and his extraordinary expertness in managing them, was not able to make any use of these. With that which magnifies the least, he was not able to see any object with satisfaction; and he concludes his account with expressing his hopes only, that, as his eyes had been much used to microscopes, they were not injured by the attention he had given to them, though he believed there were few persons who would not have been blinded by it.

109  
Could not  
be used by  
Mr Baker.

The construction of a telescope with six eye-glasses led M. Euler to a similar construction of microscopes, by introducing into them six lenses, one of which admits of so small an aperture, as to serve, instead of a diaphragm, to exclude all foreign light, though, as he says, it neither lessens the field of view, nor the brightness of objects.

110

The improvement of all dioptric instruments is greatly impeded by inequalities in the substance of the glass of which they are made; but though many attempts have been made to make glasses without that imperfection, none of them have been hitherto quite effectual. M. A. D. Merklein, having found some glass which had been melted when a building was on fire, and which proved to make excellent object-glasses for telescopes, concluded that its peculiar goodness arose from its not having been disturbed when it was in a fluid state; and therefore he proposed to take the metal out of the furnace in iron vessels, of the same form that was wanted for the glass; and after it had been perfectly fluid in those vessels, to let it stand to cool, without any disturbance. But this is not always found to answer.

## PART II. THEORY OF OPTICS.

THIS part of the science contains all that hath been discovered concerning the various motions of the rays of light either through different mediums, or when reflected from different substances in the same medium. It contains also the rationale of every thing which hath been discovered with regard to vision; the optical deceptions to which we are liable; and, in short, ought to give the reason of all the known optical phenomena.—The science is commonly divided into three parts, viz. dioptrics, which contains the laws of refraction, and the phenomena depending upon them; catoptrics, which contains the laws of reflection, and the phenomena which depend on them; and lally chromatics, which treats of the phenomena of colour. But this definition is of no use in a treatise of Optics, as most of the phenomena depend both on refraction and reflection; colour itself not excepted. For this reason we have not followed that method of dividing our subject; but have explained the particular laws of refraction and reflection, afterwards showing how, by these, the most remarkable optical phenomena may be accounted for.

### SECT. I. *Of the properties of Light in general.*

WITHOUT entering into any repetition of the controversies concerning the nature of LIGHT, which are fully set forth under that article, we shall here give a brief description of its properties considered as the subject of the optical science, and which hold good in all cases without regard to other theories.

Every visible body emits or reflects inconceivably small particles of matter from each point of its surface, which issue from it continually (not unlike sparks from a coal) in straight lines and in all directions. These particles entering the eye, and striking upon the retina, (a nerve expanded on the back part of the eye to receive their impulses), excite in our minds the idea of light. And as they differ in substance, density, velocity, or magnitude, they produce in us the ideas of different colours; as will be explained in its proper place.

That the particles which constitute light are exceedingly small, appears from hence, viz. that if a hole be made through a piece of paper with a needle, rays

of light from every object on the farther side of it are capable of passing through it at once without the least confusion; for any one of those objects may as clearly be seen through it, as if no rays passed through it from any of the rest. Further, if a candle is lighted, and there be no obstacle in the way to obstruct the progress of its rays, it will fill all the space within two miles of it every way with luminous particles, before it has lost the least sensible part of its substance thereby.

That these particles proceed from every point of the surface of a visible body, and in all directions, is clear from hence, *viz.* because wherever a spectator is placed with regard to the body, every point of that part of the surface which is turned towards him is visible to him. That they proceed from the body in right lines, we are assured, because just so many and no more will be intercepted in their passage to any place by an interposed object, as that object ought to intercept, supposing them to come in such lines.

The velocity with which they proceed from the surface of the visible body is no less surprising than their minuteness: the method whereby philosophers estimate their swiftness, is by observations made on the eclipses of Jupiter's satellites; which eclipses to us appear about seven minutes sooner than they ought to do by calculation, when the earth is placed between the sun and him, that is, when we are nearest to him; and as much later, when the sun is between him and us, at which time we are farthest from him; from whence it is concluded, that they require about seven minutes to pass over a space equal to the distance between the sun and us, which is about 95,000,000 of miles.

A stream of these particles issuing from the surface of a visible body in one and the same direction, is called a *ray of light*.

As rays proceed from a visible body in all directions, they necessarily become thinner and thinner, continually spreading themselves as they pass along into a larger space, and that in proportion to the squares of their distances from the body; that is, at the distance of two spaces, they are four times thinner than they are at one; at the distance of three spaces, nine times thinner, and so on: the reason of which is, because they spread themselves in a twofold manner, *viz.* upwards and downwards, as well as sidewise.

The particles of light are subject to the laws of attraction of cohesion, like other small bodies; for if a ray of light be made to pass by the edge of a knife, it will be diverted from its natural course, and be inflected towards the edge of the knife. The like inflection happens to a ray when it enters obliquely into a denser or rarer substance than that in which it was before, in which case it is said to be refracted; the laws of which refraction are the subject of the following section.

### SECT. II. Of Refraction.

LIGHT, when proceeding from a luminous body, without being reflected from any opaque substance, or inflected by passing very near one, is invariably found to proceed in straight lines, without the least deviation. But if it happens to pass from one medium to another, it always leaves the direction it had before, and assumes a new one; and this change of course is

called its *refraction*. After having taken this new direction, it then proceeds invariably in a straight line till it meets with a different medium, when it is again turned out of its course. It must be observed, however, that tho' by this means we may cause the rays of light make any number of angles in their course, it is impossible for us to make them describe a curve, except in one single case, namely, where they pass through a medium, the density of which uniformly either increases or decreases. This is the case with the light of the celestial bodies, which passes downwards thro' our atmosphere, and likewise with that which is reflected upwards through it by terrestrial objects. In both these cases, it describes a curve of the hyperbolic kind; but at all other times it proceeds in straight lines, or in what may be taken for straight lines without any sensible error.

#### § 1. The cause of Refraction, and the law by which it is performed.

THE phenomena of refraction are explained by the attractive power in the medium through which light passes, in the following manner. All bodies being endued with an attractive force, which is extended to some distance beyond their surfaces; when a ray of light passes out of a rarer into a denser medium (if this latter has a greater attractive force than the former, as is commonly the case) the ray, just before its entrance, will begin to be attracted towards the denser medium; and this attraction will continue to act upon it, till some time after it has entered the medium; and therefore, if a ray approaches a denser medium in a direction perpendicular to its surface, its velocity will be continually accelerated during its passage through the space in which that attraction exerts itself; and therefore, after it has passed that space, it will move on, till it arrives at the opposite side of the medium, with a greater degree of velocity than it had before it entered. So that in this case its velocity only will be altered. Whereas, if a ray enters a denser medium obliquely, it will not only have its velocity augmented thereby, but its direction will become less oblique to the surface. Just as when a stone is thrown downwards obliquely from a precipice, it falls to the surface of the ground in a direction nearer to a perpendicular one, than that with which it was thrown from the hand. From hence we see a ray of light, in passing out of a rarer into a denser medium, is refracted towards the perpendicular; that is, supposing a line drawn perpendicularly to the surface of the medium, through the point where the ray enters; and extended both ways, the ray in passing through the surface is refracted or bent towards the perpendicular line; or, which is the same thing, the line which it describes by its motion after it has passed through the surface, makes a less angle with the perpendicular, than the line it described before. All which may be illustrated in the following manner.

Let us suppose first, that the ray passes out of a vacuum into the denser medium ABCD, (fig. 4.) and that the attractive force of each particle in the medium is extended from its respective centre to a distance equal to that which is between the lines AB and EF, or AB and GH; and let KL be the path described by a ray of light in its progress towards the denser

Of Refraction.

Of Refraction.

medium. This ray, when it arrives at L, will enter the attractive forces of those particles which lie in AB the surface of the denser medium, and will therefore cease to proceed any longer in the right line KLM, but will be diverted from its course by being attracted towards the line AB, and will begin to describe the curve LN, passing thro' the surface AB in some new direction, as OQ; thereby making a less angle with a line, as PR, drawn perpendicularly through the point N, than it would have done had it proceeded in its first direction KLM.

Farther, whereas we have supposed the attractive force of each particle to be extended through a space equal to the distance between AB and EF, it is evident, that the ray, after it has entered the surface, will still be attracted downwards, till it has arrived at the line EF; for, till that time, there will not be so many particles above it which will attract it upwards, as below, that will attract it downwards. So that after it has entered the surface at N, in the direction OQ, it will not proceed in that direction, but will continue to describe a curve, as NS; after which it will proceed straight on towards the opposite side of the medium, being attracted equally every way; and therefore will at last proceed in the direction XST, still nearer the perpendicular PR than before.

Now if we suppose ABYZ not to be a vacuum, but a rarer medium than the other, the case will still be the same; but the ray will not be so much refracted from its rectilinear course, because the attraction of the particles of the upper medium being in a contrary direction to that of the attraction of those in the lower one, the attraction of the denser medium will in some measure be destroyed by that of the rarer.

On the contrary, when a ray passes out of a denser into a rarer medium, if its direction be perpendicular to the surface of the medium, it will only lose somewhat of its velocity, in passing through the spaces of attraction of that medium (that is, the space wherein it is attracted more one way than it is another.) If its direction be oblique, it will continually recede from the perpendicular during its passage, and by that means have its obliquity increased, just as a stone thrown up obliquely from the surface of the earth increases its obliquity all the time it rises. Thus, supposing the ray TS passing out of the denser medium ABCD into the rarer ABYZ, when it arrives at S it will begin to be attracted downwards, and so will describe the curve SNL, and then proceed in the right line LK; making a larger angle with the perpendicular PR, than the line TSX in which it proceeded during its passage through the other medium.

The space through which the attraction of cohesion of the particles of matter is extended is so very small, that in considering the progress of a ray of light out of one medium into another, the curvature it describes in passing through the space of attraction is generally neglected; and its path is supposed to be bent, or, in the usual terms, the ray is supposed to be refracted only in the point where it enters the denser medium.

Now the line which a ray describes before it enters a denser or a rarer medium, is called the *incident ray*; that which it describes after it has entered, is the *refracted ray*.

The angle comprehended between the incident ray

and the perpendicular, is the *angle of incidence*; and that between the refracted ray and the perpendicular, is the *angle of refraction*.

There is a certain and immutable law or rule, by which refraction is always permitted; and that is this: Whatever inclination a ray of light has to the surface of any medium before it enters it, the degree of refraction will always be such, that the proportion between the sine of the angle of its incidence, and that of the angle of its refraction, will always be the same in that medium.

To illustrate this: Let us suppose ABCD (fig. 5.) to represent a rarer, and ABEF a denser medium: let GH be a ray of light passing through the first and entering the second at H, and let HI be the refracted ray; then supposing the perpendicular PR drawn thro' the point H, on the centre H, and with any radius, describe the circle APBR; and from G and I, where the incident and refracted rays cut the circle, let fall the lines GK and IL perpendicularly upon the line PR: the former of these will be the line of the angle of incidence, the latter of refraction. Now if in this case the ray GH is so refracted at H, that GK is double or triple, &c. of IL, then, whatever other inclination the ray GH might have had, the sine of its angle of incidence would have been double or triple, &c. to that of its angle of refraction. For instance, had the ray passed in the line MH before refraction, it would have passed in some line as HN afterwards, so situated that MO should have been double or triple &c. of NQ.

When a ray passes out of a vacuum into air, the sine of the angle of incidence is found to be to that of refraction, as 100036 to 100000.

When it passes out of air into water, as about 4 to 3.

When out of air into glass, as about 17 to 11.

When out of air into a diamond, as about 5 to 2.

This relation of the sine of the angle of incidence to that of refraction may be demonstrated mathematically in the following manner.

*Lemma.* If from a point at M (fig. 6.) taken any where without the circle PNQ, a line as MP be drawn passing through L the centre of the circle, and terminated in the circumference at P, the product of MQ multiplied by MP is equal to the difference between the squares of ML and PL.

*Demonstration of the Lemma.* Call MQ,  $a$ ; and the radius of the circle LQ or LP,  $b$ ; then will the diameter QP be expressible by  $2b$ , and the whole line MP, by  $a+2b$ ; then multiplying MQ by MP, that is,  $a$  by  $a+2b$ , we have for the product of this,  $aa+2ab$ . Now the square of the line ML, which is expressible by  $a+b$ , is  $aa+2ab+bb$ ; and the square of PL is  $bb$ ; but the difference between these squares, viz.  $aa+2ab+bb$  and  $bb$ , is evidently  $aa+2ab$ ; and therefore the product of MQ multiplied by MP is equal to the difference between the squares of ML and PL. Q. E. D.

*Demonstration of the Proposition.* When a ray of light passes through the space of attraction of any medium, it is evident that its motion will be subject to the like laws with that of projectiles, provided we suppose it to be acted upon with an equal degree of force during its whole passage through that space, as is commonly supposed to be the case in projectiles to what-

Plate  
CCVIII.

Plate  
CCVIII.+ See the  
article, Pro-  
jectiles.

ever height they are thrown from the earth. We will therefore suppose first, that the force of attraction of the denser medium is at all distances the same as far as it reaches, and that the ray proceeds out of a denser into a rarer medium; in which case it will be attracted back towards the denser medium, during its passage thro' the space of attraction, in like manner as a projectile thrown upwards is while it rises from the earth. Let then ABCD (fig. 6.) represent the denser medium, and ABEF the space of attraction; and let GH be a ray about to enter the force of attraction at H, and let GH be produced to M. Now it is evident, that, in this supposition, the ray, when at H, is in the same circumstances with a projectile about to be thrown upwards from H towards M: it will therefore describe a portion of a parabola as HI; to which the line HM will be a tangent at H; and the line IK, in which it would proceed after it had passed the space of attraction, a tangent to it at I; for after having left the attractive force at I, it goes straight on in its last direction. Let the perpendicular IR be drawn meeting GH produced in M, and let KI be produced to L. On the centre L, with the radius LI, describe the circle PNO, let fall the perpendicular LO upon MR, and join the points L and N. Now it is demonstrated in the case of projectiles,† that the parameter of the point H is equal to  $\frac{HM^2}{MI}$ , and therefore the parameter multiplied by MI is equal to  $HM^2$ . And it is there farther demonstrated, that the said parameter is equal to four times the height which a body must fall from, to acquire the velocity the projectile has at H. This parameter therefore is a quantity not at all depending on the direction of the projectile, but on its velocity only; and consequently, in the present supposition, it is a given quantity, the ray GH being supposed to have the same velocity, whatever is its inclination to the surface HB. Now the tangent KI being produced to L, will, by the property of the parabola, bisect the other tangent HM: wherefore the line LO being parallel to HR, MR will also be bisected in O; and adding the equal lines OI and ON to each part, MN will be equal to IR; but the line IR is also a line independent of the inclination of the ray GH, its length being determined by the breadth of the space of attraction ABEF only, and therefore MN is a given quantity. Now, whereas MI, when multiplied by the parameter of the point H, which before was shewn to be a given line, is equal to the square of HM, therefore the same line MI, when multiplied by any other given line (*viz.* MN) if it is not equal to, will nevertheless bear a given proportion to, the square of HM: but since MI multiplied by MN bears a given proportion (*viz.* a proportion that does not depend on the inclination of the ray GH) to the square of MH, its equal, *viz.* the product of MQ multiplied by MP, or what is equal to this, the difference between the squares of ML and PL (by the foregoing lemma), or, which is the same thing, of ML and LI, (because PL and LI are radii of the same circle), does so too. Now the square of ML bears also a given proportion to the square of MH (ML being equal to half MH); consequently there is a given proportion between the square of ML and the difference of the squares of ML and LI; and therefore there is a certain proportion between the lines them-

selves, *viz.* between ML and LI. But in every triangle the sides are proportionable to the sines of their opposite angles; therefore in the triangle MLJ, the sine of the angle LMI has a given proportion to the sine of the angle LIM, or of its complement to two right ones MIK (for they have the same sine): But LMI, being an angle made by the incident ray GH produced, with the perpendicular RM, is the angle of incidence; and MIK, being made by the refracted ray IK, and the same perpendicular, is the angle of refraction; therefore in this case there is a constant ratio between the sine of the angle of incidence, and that of the angle of refraction.

We have here supposed that the force of attraction is every where uniform; but if it be otherwise, provided it be the same every where at the same distances from the surface AB, the proportion between the fore-mentioned sines will still be a given one. For, let us imagine the space of attraction divided into parallel planes, and the attraction to be the same through the whole breadth of each plane though different in different planes, the sine of the angle of incidence out of each will, by what has been demonstrated above, be to the sine of the angle of refraction into the next in a given ratio; and therefore, since the sine of the angle of refraction out of one will be the sine of the angle of incidence into the next, it is evident that the sine of the angle of incidence into the first will be in a given ratio to the sine of the angle of refraction out of the last. Now let us suppose the thickness of these planes diminished in *infinitum*, and their number proportionably increased, the law of refraction will still continue the same; and therefore, whether the attraction be uniform or not, there will be a constant ratio between the sine of the angle of incidence and of refraction. Q. E. D.

For the same reason that a ray is bent towards the perpendicular when passing from a rare medium into one that is denser, it is refracted from the perpendicular when it passes from a dense medium into one that is rarer—From this and the foregoing proposition may be deduced the following corollaries.

I. When parallel rays fall obliquely on a plane surface of a medium of different density, they are parallel also after refraction; for, having all the same inclination to the surface, they suffer an equal degree of refraction.

II. When diverging rays pass out of a rarer into a denser medium through a plain surface, they are made thereby to diverge less.

III. When they proceed out of a denser into a rarer medium, the contrary happens, and they diverge more.

IV. When converging rays pass out of a rarer into a denser medium through a plain surface, they are made thereby to converge less.

V. When converging rays proceed out of a denser into a rarer medium, they are refracted the contrary way, and so made to converge more.

All these may be illustrated in the following manner. 1. Let AB, CD (fig. 7.) be two parallel rays falling on the plain surface EF of a medium of different density: now because they both make equal angles of incidence with their respective perpendiculars GH, IK, before refraction, they will make equal angles of refraction.



refraction with them afterwards, and so proceed on in the parallel lines BL, DM. 2. Let the diverging rays AB, AE, AF, (fig. 8.) pass out of a rarer into a denser medium through the plain surface GH, and let the ray AB be perpendicular to that surface; the rest being refracted towards their respective perpendiculars EK, FM, and those the most that fall the farthest from B, they will proceed in the directions EN and FO, diverging in a less degree from the ray AP than they did before refraction. 3. Had they proceeded out of a denser into a rarer medium, they would have been refracted from their perpendicular EK, FM; and those the most which were the most oblique, and therefore would have diverged more than before. 4. Let the converging rays AB, CD, EF (fig. 9.) pass out of a rarer into a denser medium through the plain surface GH, and let the ray AB be perpendicular to that surface; then the other rays being refracted towards their respective perpendiculars DK, FM; and EF, for instance, more than CD; they will proceed in the directions DN, FN, converging in a less degree towards the ray AN, than they did before. 5. Lastly, had the first medium been the denser, they would have refracted the other way, and therefore converged more.

VI. When rays proceed out of a rarer into a denser medium through a convex surface of the denser, if they are parallel before refraction, they become converging afterwards.—For in this case the perpendiculars at the points where the rays enter the surface are all drawn from the centre of the convexity on the other side; and therefore, as the rays are refracted towards these perpendiculars, they are necessarily refracted towards each other, and thereby made to converge.

VII. If they enter diverging, then for the same reason they are made to diverge less, to be parallel, or to converge, according to the degree of divergency they have before they enter.

For, if they diverge very much, their being bent towards their respective perpendiculars in passing thro' the surface, may only diminish the divergency; whereas, if they diverge in a small degree, it may make them parallel, or even to converge.

VIII. If they converge in such a manner as to tend directly towards the centre of convexity before they enter the surface, they fall in with their respective perpendiculars, and so pass on to the centre without suffering any refraction.

IX. If they converge less than their perpendiculars, that is, if they tend to a point beyond the centre of convexity, they are made by refraction to converge more; and if they converge more than their perpendiculars, that is, if they tend towards a point between the centre and the surface, then, by being refracted towards them, they are made to converge less.

This and the three foregoing corollaries may be illustrated in the following manner. 1. Let AB, CD (fig. 10.) be two parallel rays entering a denser medium through the convex surface DB, whose centre of convexity is E; and let one of these, viz. AB, be perpendicular to the surface. This will pass on through the centre, without suffering any refraction; but the other being oblique to the surface, will be refracted towards the perpendicular ED, and will

therefore be made to proceed in some line, as DG, converging towards the other ray, and meeting it in G, which point for that reason is called the *focus*. 2. Had the ray CD diverged from the other, suppose in the line AD, it would, by being refracted towards its perpendicular ED, have been made either to diverge less, be parallel, or made to converge. 3. Let the line ED be produced to F, and if the ray had converged, so as to have described the line FD, it would have been coincident with its perpendicular, and have suffered no refraction at all. 4. If it had proceeded from any point between C and F, as from H, or, which is the same thing, towards any point beyond E in the line BE produced, it would have been made to converge more by being refracted towards the perpendicular DE, which converges more than it; and, had it proceeded from the same point, as I, on the other side of F, that is towards any point between B and E, it would then have converged more than its perpendicular, and so, being refracted towards it, would have been made to have converged less.

X. When rays proceed out of a denser into a rarer medium through a concave surface of the denser, the contrary happens in each case.

For, being now refracted from their respective perpendiculars, as they were before towards them, if they are parallel before refraction, they diverge afterwards; if they diverge, their divergency is increased; if they converge in the direction of their perpendiculars, they suffer no refraction; if they converge less than their respective perpendiculars, they are made to converge still less, to be parallel, or to diverge; if they converge more, their convergency is increased. All which may be clearly seen by the figure, without any further illustration; imagining the rays AD, CD, &c. bent the contrary way in their refractions to what they were in the former cases.

XI. When rays proceed out of a rarer into a denser medium through a concave surface of the denser, if they are parallel before refraction, they are made to diverge.—For in this case the perpendiculars at the points where the rays enter the surface, being drawn from a point on that side of the surface from which the rays tend; if we conceive them to pass through the surface, they will be so many diverging lines on the other side; and therefore the rays, after they have passed through the same points, must necessarily be rendered diverging in being refracted towards them.

XII. If they diverge before refraction, then, for the same reason, they are made to diverge more.

XIII. Unless they proceed directly from the centre; in which case they fall in with their perpendiculars, and suffer no refraction: Or from some point between the centre of convexity and the surface; for then they diverge more than their respective perpendiculars, and therefore being by refraction brought towards them they become less diverging.

XIV. If they converge, then, being refracted towards their perpendiculars, they are either made less converging, parallel, or diverging, according to the degree they converged in before refraction.

To illustrate this, and the three foregoing cases, 1. Let AB, CD (fig. 11.) be two parallel rays entering the concave and denser medium X, the centre of whose convexity is E, and the perpendicular to the refracting;

refracting surface at the point D is EF: the ray AB, if we suppose it perpendicular to the surface at B, will proceed directly to G; but the oblique one CD being refracted towards the perpendicular DF, will recede from the other ray AG in some line as DH. 2. If the ray CD had proceeded from A, diverging in the direction AD, it would have been bent nearer the perpendicular, and therefore have diverged more. 3. But if it had diverged from the centre E, it would have fallen in with the perpendicular EF, and not have been refracted at all; and had it proceeded from S, a point on the other side of the centre E, it would, by being refracted towards the perpendicular DF, have proceeded in some line nearer it than it would otherwise have done, and so would diverge less than before refraction. 4. If it had converged in the line LD, it would have been rendered less converging, parallel, or diverging, according to the degree of convergence which it had before it entered into the refracting surface.

XV. If the same rays proceed out of a denser into a rarer medium, through a convex surface of the denser, the contrary happens in each supposition. The parallels are made to converge; those which diverge less than their respective perpendiculars, that is, those which proceed from a point beyond the centre, are made less diverging, parallel, or converging, according to the degree in which they diverge before refraction; those which diverge more than their respective perpendiculars, that is, those which proceed from a point between the centre and the refracting surface, are made to diverge still more; and those which converge are made to converge more. All which may easily be seen by considering the situation of the rays AB, CD, &c. with respect to the perpendicular EF; and therefore requires no further illustration.

XVI. When diverging rays are by refraction made to converge, the nearer the radiant point (or point whence the rays proceed) is to the refracting surface, the farther is their focus from it on the other side, and *vice versa*. For the nearer the radiant point is to the refracting surface, the more the rays which fall upon the same points of it diverge before refraction, upon which account they converge the less afterwards.

XVII. When the radiant point is at that distance from the surface at which parallel rays coming through it from the other side would be collected by refraction, then rays flowing from that point become parallel on the other side, and are said to have their focus at an infinite distance. For the power of refraction in the medium is the same, whether the ray passes one way or other. For instance, if the parallel rays AB, CD, (fig. 10.) in passing through the refracting surface BD, are brought to a focus in G, then rays flowing from G as a radiant point, will afterwards proceed in the parallel lines BA and DC. And the point G, where the parallel rays AB and CD meet after refraction, is called the *focus of parallel rays*.

XVIII. When rays proceed from a point nearer the refracting surface than the focus of parallel rays, they continue to diverge after refraction, and their focus is then an imaginary one, and situated on the same side of the surface with the radiant. For, in this case, the divergency being greater than that which they would have if they had proceeded from the focus

of parallel rays, they cannot be brought to a parallelism with one another, much less to converge; and therefore they continue to diverge, though in a less degree than before they passed through the refracting surface: upon which account they proceed after refraction as if they came from some point farther distant from the refracting surface than their radiant.

All these corollaries may be expressed more determinately, and demonstrated, in the following manner:

I. When rays pass out of one medium into another of different density through a plain surface; if they diverge, the focal distance will be to that of the radiant point; if they converge, it will be to that of the imaginary focus of the incident rays, as the sine of the angle of incidence is to that of the angle of refraction.

This proposition admits of four cases.

CASE 1. Of diverging rays passing out of a rarer into a denser medium.

DEM. Let X (fig. 12.) represent a rarer, and Z a denser medium, separated from each other by the plane surface AB; suppose CE and CD to be two diverging rays proceeding from the point C, the one perpendicular to the surface, the other oblique; through E draw the perpendicular PK. The ray CD being perpendicular to the surface, will proceed on in the right line CQ; but the other falling on it obliquely at E, and there entering a denser medium, will suffer a refraction towards the perpendicular EK. Let then EG be the refracted ray, and produce it back till it intersects DC produced also in F; this will be the focal point. On the centre E, and with the radius EF, describe the circle AFBQ, and produce EC to H; draw HI the sine of the angle of incidence, and GK that of refraction; equal to this is FP or CM, which let be drawn. Now if we suppose the points D and E contiguous, or nearly so, then will the line HE be almost coincident with FD, and therefore FD will be to CD as HE to CE; but HE is to CE as HI to CM, because the triangles HIE and CME are similar; that is, the focal distance of the ray CE is to the distance of the radiant point, as the sine of the angle of incidence is to that of the angle of refraction.

Q. E. D.

Obs. 1. Whereas the ratio of FE to ME, or, which is the same thing, that of  $nD$  to  $CD$ , bears the exact proportion of HI to CM, and because this (being the ratio of the sine of the angle of incidence to that of the angle of refraction) is always the same, the line  $n$  is in all inclinations of the ray CE, at the same distance from CM; consequently, had CE been coincident with CD, the point H had fallen upon  $n$ ; and because the circle passes through both H and F, F would also have fallen upon  $n$ ; upon which account the focus of the ray CE would have been there. But the ray CE being oblique to the surface DB, the point H is at some distance from  $n$ ; and therefore the point F is necessarily so too, and the more so by how much the greater that distance is: from whence it is clear, that no two rays flowing from the radiant point C, and falling with different obliquities on the surface BD, will, after refraction there, proceed as from the same point; therefore, strictly speaking, there is no

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Of  
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one point in the line D produced, that can more properly be called the *focus of rays flowing from C*, than another: for those which enter the refracting surface near D, will after refraction proceed, as has been observed, from the parts about *n*; those which enter near E, will flow as from the parts about F; those which enter about T, as from some points in the line DF produced, &c. And it is farther to be observed, that, when the angle DCE becomes large, the line *nF* increases apace; wherefore those rays which fall near T, proceed, after refraction, as from a more diffused space than those which fall at the same distance from each other near the point D. Upon which account it is usual with optical writers to suppose the distance between the points where the rays enter the plain surface of a refracting medium, to be inconsiderable with regard to the distance of the radiant point, if they diverge; or to that of their imaginary focus, if they converge: and unless there be some particular reason to the contrary, they consider them as entering the refracting medium in a direction as nearly perpendicular to its surfaces as may be.

CASE 2. Of diverging rays proceeding out of a denser into a rarer medium.

DEM. Let X be the denser, Z the rarer medium, FD and FE two diverging rays proceeding from the point F; and supposing the perpendicular PK drawn as before, FP will be the sine of the angle of incidence of the oblique ray FE; which in this case being refracted from the perpendicular, will pass on in some line as ER, which being produced back to the circumference of the circle, will cut the ray FD somewhere, suppose in C; this therefore will be the imaginary focus of the refracted ray ER: draw RS the sine of the angle of refraction, to which HI will be equal: but here also FP, or its equal CM, is to HI as EC to EH, or (if the point D and E be considered as contiguous) as DC to DF; that is, the sine of the angle of incidence is to the sine of the angle of refraction, as the focal distance to that of the radiant point. Q. E. D.

CASE 3. Of converging rays passing out of a denser medium into a rarer.

DEM. Let Z be the denser, X the rarer medium, and GE the incident ray; this will be refracted from the perpendicular into a line, as EH; then all things remaining as before, GK, or its equal FP, or CM, will be the sine of the angle of incidence, and HI that of refraction: but these lines, as before, are to each other as DC to DF; that is, the focal distance is to the distance of the imaginary focus, as the sine of the angle of incidence to that of the angle of refraction. Q. E. D.

CASE 4. Of converging rays passing out of a rarer into a denser medium.

DEM. Let Z be the rarer, X the denser medium, and RE the incident ray; this will be refracted towards the perpendicular into a line, as EF; C will be the imaginary focus, and F the real one; HI, which is equal to RS, the sine of the angle of incidence, and FP that of the angle of refraction: but these are to each other, as DF to DC; and therefore the focal distance is to that of the imaginary focus, as the sine of the angle of incidence is to that of the angle of refraction. Q. E. D.

II. When parallel rays fall upon a spherical surface of different density, the focal distance will be to the distance of the centre of convexity, as the sine of the angle of incidence is to the difference between that sine and the sine of the angle of refraction.

This proposition admits of four cases.

CASE 1. Of parallel rays passing out of a rarer into a denser medium, through a convex surface of the denser.

DEM. Let AB (fig. 13.) represent a convex surface; C its centre of convexity; HA and DB two parallel rays, passing out of the rarer medium X into the denser Z, the one perpendicular to the refracting surface, the other oblique: draw CB; this being a radius, will be perpendicular to the surface at the point B; and the oblique ray DB, being in this case refracted towards the perpendicular, will proceed in some line, as BF, meeting the other ray in F, which will therefore be the focal point: produce CB to N; then will DBN, or its equal BCA, be the angle of incidence, and FBC that of refraction. Now, whereas any angle has the same sine with its complement to two right ones, the angle FCB being the complement of ACB, which is equal to the angle of incidence, may here be taken for that angle; and therefore, as the sides of a triangle have the same relation to each other that the sines of their opposite angles have, FB being opposite to this angle, and FC being opposite to the angle of refraction, they may here be considered as the sines of the angles of incidence and of refraction. And for the same reason CB may be considered as the sine of the angle CFB; which angle being, together with the angle FBC, equal to the external one ACB, (32. El. 1.) is itself equal to the difference between those two last angles; and therefore the line FB is to CB as the sine of the angle of incidence is to the sine of an angle which is equal to the difference between the angle of incidence and of refraction. Now, because in very small angles as these are, (for we suppose in this case also the distance AB to vanish, the reason of which will be shown by-and-by,) their sines bear nearly the same proportion to each other that they themselves do, the distance FB will be to CB as the sine of the angle of incidence is to the difference between that sine and the sine of the angle of refraction; but because BA vanishes, FB and FA are equal, and therefore FA is to CA in that proportion. Q. E. D.

Obs. 2. It appears from the foregoing demonstration, that the focal distance of the oblique ray DB is such, that the line BF shall be to the line CB or CA as the sine of the angle of incidence to the sine of an angle, which angle is equal to the difference between the angle of incidence and refraction; therefore, so long as the angles BCA, &c. are small, so long the line BF is pretty much of the same length, because small angles have nearly the same relation to each other that their sines have. But when the point B is removed far from A, so that the ray DB enters the surface, suppose about O, the angles BCA, &c. becoming large, the sine of the angle of incidence begins to bear a considerably less proportion to the sine of an angle which is equal to the difference between the angle of incidence and refraction than before, and therefore the line BF begins to bear a much less proportion to BC; wherefore its length decreases apace: upon which account those rays which enter the surface

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about O, not only meet nearer the centre of convexity than those which enter at A, but are collected into a more diffused space. From hence it is, that the point where those only which enter near A are collected, is reckoned the true focus; and the distance AB in all demonstrations relating to the foci of parallel rays entering a spherical surface whether convex or concave, is supposed to vanish.

CASE 2. Of parallel rays passing out of a denser into a rarer medium through a concave surface of the denser.

DEM. Let X be the denser, Z the rarer medium. AB the surface by which they are separated, C the centre of convexity, and HA and DB two parallel rays, as before. Through B, the point where the oblique ray DB enters the rarer medium, draw the perpendicular CN; and let the ray DB, being in this case refracted from the perpendicular, proceed in the direction BM; produce BM back to H; this will be the imaginary focus; and DBN, or its equal ACB, will be the angle of incidence, and CBM, or its equal HBN (for they are vertical) that of refraction: produce DB to L, and draw BF such, that the angle LBF may be equal to DBH: then because NBD and DBH together are equal to NBH the angle of refraction, therefore BCA which is equal to the first, and LBF which is equal to the second, are together equal to the angle of refraction; but LBF is equal to BFA (as being alternate to it); consequently BFA and BCA together are equal to the angle of refraction; and therefore since one of them, *viz.* BCA, is equal to the angle of incidence, the other is the difference between that angle and the angle of refraction. Now FB, the sine of the angle FCB, or, which is the same thing, of its complement to two right ones, BCA, the angle of incidence, is to CB the sine of the angle BFC, as FB to CB, that is, as HB to CB; for the angles DBH and LBF being equal, the lines BF and BH are so too; but the distance BA vanishing, HB is to CB, as HA to CA: that is, the sine of the angle of incidence is to the sine of an angle which is the difference between the angle of incidence and refraction, or, because the angles are small, to the difference between the sine of the angle of incidence and that of refraction, as the distance of the focus from the surface is to that of the centre from the same.  $\mathcal{Q}$  E. D.

CASE 3. Of parallel rays passing out of a rarer into a denser medium through a concave surface.

DEM. Let X be the denser medium having the concave surface AB, and let LB and FA be the incident rays. Now, whereas, when DB was the incident ray, and passed out of a rarer into a denser medium, as in Case 1. it was refracted into the line BF, this ray LB, having the same inclination to the perpendicular, will also suffer the same degree of refraction, and will therefore pass on afterwards in the line FB produced, *v. g.* towards P. So that, whereas in that case the point F was the real focus of the incident ray DB, the same point will in this be the imaginary focus of the incident ray LB: but it was there demonstrated, that the distance FA is to CA, as the sine of the angle of incidence is to the difference between that and the sine of the angle of refraction; therefore the focal distance of the refracted ray BP is

to the distance of the centre of convexity in that proportion.  $\mathcal{Q}$  E. D.

CASE 4. Of parallel rays passing out of a denser into a rarer medium through a convex surface of the denser.

DEM. Let Z be the denser medium, having the convex surface AB, and let LB and FA be the incident rays, as before. Now, whereas, when DB was the incident ray passing out of a denser into a rarer medium, it was refracted into BM, as in Case 2. having a point as H in the line MB produced for its imaginary focus; therefore LB, for the like reason as was given in the last case, will in this be refracted into BH, having the same point H for its real focus. So that here also the focal distance will be to that of the centre of convexity, as the sine of the angle of incidence is to the difference between that and the sine of the angle of refraction.  $\mathcal{Q}$  E. D.

III. When diverging or converging rays enter into a medium of different density through a spherical surface, the ratio compounded of that which the focal distance bears to the distance of the radiant point (or of the imaginary focus of the incident rays, if they converge), and of that which the distance between the same radiant point (or imaginary focus) and the centre bears to the distance between the centre and focus, is equal to the ratio which the sine of the angle of incidence bears to the sine of the angle of refraction.

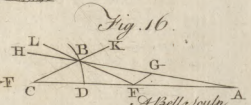
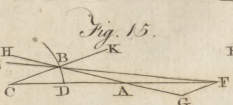
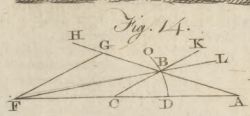
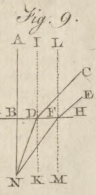
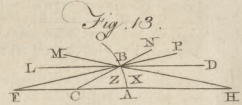
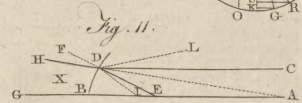
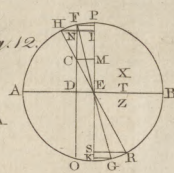
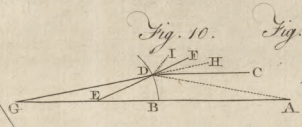
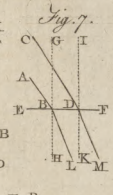
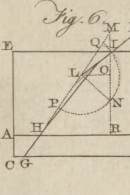
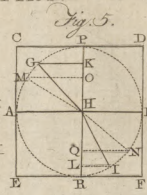
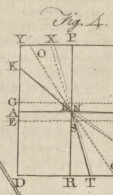
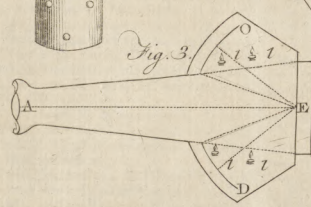
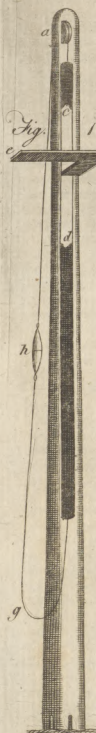
This proposition admits of 16 cases.

CASE 1. Of diverging rays passing out of a rarer into a denser medium, thro' a convex surface of the denser, with such a degree of divergency, that they shall converge after refraction.

Plate  
CCVIII.

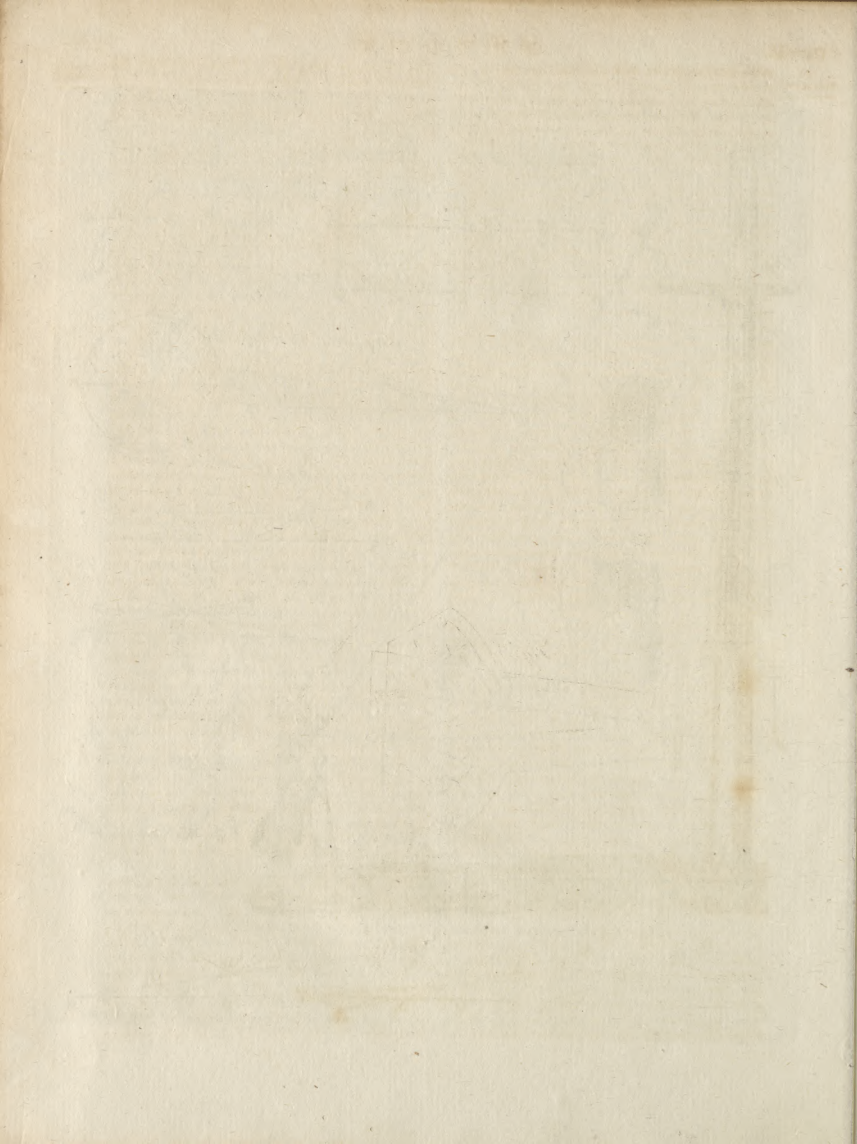
DEM. Let BD (fig. 14.) represent a spherical surface, C its centre of convexity; and let there be two diverging rays AB and AD proceeding from the radiant point A, the one perpendicular to the surface, the other oblique. Thro' the centre C produce the perpendicular one to F; and draw the radius CB, and produce it to K, and let BF be the refracted ray; then will F be the focal point; produce AB to H, and through the point F draw the line FG parallel to CB. AB being the incident ray, and CK perpendicular to the surface at the point B, the angle ABK, or, which is equal to it, because of the parallel lines CB and FG, FGH, is the angle of incidence. Now, whereas, the complement of any angle to two right ones has the same sine with the angle itself, the sine of the angle FGB, that being the complement of FGH to two right ones, may be considered as the sine of the angle of incidence; which sine the line FB, as the sides of a triangle have the same relation to each other that the sines of their opposite angles have, may be taken for. Again, the angle FBC is the angle of refraction, or its equal, because alternate to it, BFG; to which BG, being an opposite side, may be looked upon as the sine. But FB is to BG in a ratio compounded of FB to BA, and of BA to BG; for the ratio that any two quantities bear to each other, is compounded of the ratio which the first bears to any other, and of the ratio which that other bears to the second. Now FB is to BA, supposing BD to vanish, as FD to DA; and BA is to BG, because of the parallel lines CB and FG, as AC to CF. That is, the

ratio



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of  
RefractionPlate  
CCVIII.  
fig. 14.

ratio compounded of FD the focal distance, to DA the distance of the radiant point, and of AC, the distance between the radiant point and the centre, to CF, the distance between the centre and the focus, is equal to that which the sine of the angle of incidence bears to the sine of the angle of refraction. *Q. E. D.*

ONS. Whereas the focal distance of the oblique ray AB is such, that the compound ratio of FB to BA and of AC to CF, shall be the same, whatever be the distance between B and D; it is evident, that since AC is always of the same length, the more the line AB lengthens, the more FB must lengthen too, or else FC must shorten; but it appears by inspection of the figure, that if BF lengthens, CF will do so too, and in a greater proportion with respect to its own length than BF will; therefore the lengthening of BF will conduce nothing towards preserving the equality of the proportion; but as AB lengthens, BF and CF must both shorten, which is the only possible way wherein the proportion may be continued the same. And it is also apparent, that the farther B moves from D towards O, the farther AB lengthens; and therefore the farther the rays enter from D, the nearer to the refracting surface is the place where they meet, but the space they are collected in is the more diffused: and therefore, in this case, as well as those taken notice of in the two foregoing observations, different rays, tho' flowing from the same point, shall constitute different foci; and none are so effectual as those which enter at, or very near, the point D. And since the same is observable of converging as well as of diverging rays, none except those which enter very near that point are usually taken into consideration; upon which account it is, that the distance DB, in determining the focal distances of diverging or converging rays entering a convex or concave surface, is supposed to vanish.

Those who would see a method of determining the precise point, which the ray AB, whether it be parallel, converging, or diverging to the ray AF, converges to or diverges from after refraction at B or any other given point in the surface DO, may find it in the Appendix to Molineux's Optics; which, for the sake of those who have not the book, we shall subjoin at the end of this section.

CASE 2. Of converging rays passing out of a rarer into a denser medium through a concave surface of the denser with such a degree of convergency, that they shall diverge after refraction.

DEM. Let the incident rays be HB and FD passing out of a rarer into a denser medium thro' the concave surface BD, and tending towards the point A, from whence the diverging rays flowed in the other case; then the oblique ray HB, having its angle of incidence HBC equal to ABK the angle of incidence in the former case, will be refracted into the line BL, such, that its refracted angle KBL will be equal to FBC the angle of refraction in the former case; that is, it will proceed after refraction in the line FB produced, having the same focal distance FD with the diverging rays AB, AD, in the other case. But, by what has been already demonstrated, the ratio compounded of FD, the focal distance, to DA, in this case, the distance of the imaginary focus of the incident rays, and of AC, the distance between the

same imaginary focus and the centre, to CF, the distance between the centre and the focus, is equal to that which the sine of the angle of incidence bears to the sine of the angle of refraction. *Q. E. D.*

CASE 3. Of diverging rays passing out of a rarer into a denser medium through a convex surface of the denser with such a degree of divergency as to continue diverging.

DEM. Let AB, AD (fig. 15.) be the diverging rays, and let their divergency be so great, that the refracted ray BL shall also diverge from the other; produce LB back to F, which will be the focal point; draw the radius CB, and produce it to K; produce BA likewise towards G, and draw FG parallel to PC. Then will ABK be the angle of incidence, whose sine BF may be taken for, as being opposite to the angle BGF, which is the complement of the other to two right ones. And LBC is the angle of refraction, or its equal KBF, or, which is equal to this, BFG, as being alternate; therefore BG, the opposite side to this, may be taken for the sine of the angle of refraction. But BF is to BG, for the like reason as was given in case the first, in a ratio compounded of BF to BA, and of BA to BG. Now BF is to BA, (DB vanishing) as DF to DA; and because of the parallel lines FG and BC, the triangles CBA and AGF are similar; therefore BA is to AG as CA to AF; consequently BA is to BA together with AG, that is, to BG, as CA is to CA together with AF, that is, CF. Therefore the ratio compounded of DF the focal distance to DA the distance of the radiant point, and of CA the distance between the radiant point and the centre, to CF the distance between the centre and the focus, is equal to that which the sine of the angle of incidence bears to the sine of the angle of refraction. *Q. E. D.*

CASE 4. Of converging rays passing out of a rarer into a denser medium thro' a concave surface of the denser in such manner that they shall continue converging.

DEM. Let HB and CD be the incident rays passing out of the rarer into the denser medium thro' the concave surface BD, and tending towards A the same point from whence the diverging rays flowed in the last Case. Then because the ray HB has the same inclination to the perpendicular CK that AB had before, it will suffer the same degree of refraction, and pass on in the line LB produced, having its focus F at the same distance from the refracting surface as that of the diverging ray AB in the other case. Therefore, &c. *Q. E. D.*

CASE 5. Of diverging rays passing out of a denser into a rarer medium through a convex surface of the denser.

DEM. Let AB, AD (fig. 16.) be the incident rays passing out of a denser into a rarer medium through the concave surface BD whose centre is C; and let BL be the refracted ray, which produce back to F, and draw FG parallel to CB. Here ABK is the angle of incidence, to which its alternate one FGB being equal, FB the opposite side may be considered as the sine of it. The angle of refraction is LBC or FBK; of which BFG being the complement to two right ones, BG the opposite side may be looked upon as its sine. But BF is to BG, in the

compound ratio of BF to BA, and of BA to BG, for the reason given above. Now (BD vanishing) BF is to BA as DF to DA, and BA is to BG as CA to CF; that is, the ratio compounded of the focal distance to the distance of the radiant point, &c.  $\text{Q. E. D.}$

CASE 6. Of converging rays passing out of a denser into a rarer medium through a concave surface of the denser.

DEM. Let HB, CD, be the incident rays tending towards the point A which was the radiant in the last Case. Then, for the reason already given, the oblique ray will suffer such a degree of refraction, as to have its focus F at the same distance from the surface, as the diverging rays AB, AD, had in that case. Therefore, &c.  $\text{Q. E. D.}$

When the mediums through which rays pass, and the refracting surfaces are such, that rays flowing from A (fig. 14.) are collected in F, then rays flowing from F through the same mediums the contrary way, will be collected in A. For when rays pass out of one medium into another, the sine of the angle of incidence bears the same proportion to the sine of the angle of refraction, as the sine of the angle of refraction does to the sine of the angle of incidence, when they pass the contrary way. This is applicable to each of the six following Cases compared respectively with the six foregoing: therefore they may be considered as the converse of them; or they may be demonstrated independently of them, as follows.

CASE 7. Of diverging rays passing out of a denser into a rarer medium through a concave surface of the denser, so as to converge afterwards.

DEM. Let AB, AD (fig. 1.) be two diverging rays passing thro' the concave surface BD into a rarer medium. Let C be the centre of concavity, and BF the refracted ray. Draw CB, and produce it to K; and draw FG parallel to it, meeting AB produced in G. Then will ABC be the angle of incidence; of which FB being opposite to its alternate and equal angle FGB, may be considered as the sine. The angle of refraction is FBK; of which GB, being opposite to its complement to two right ones GFB, may be taken for the sine. Now FB is to BG in a ratio compounded of FB to BA, and of BA to BG. But (BD vanishing) FB is to BA as FD to DA; and because of the parallel lines CB and FG, BA is to BG as CA to CF. Therefore the focal distance, &c.  $\text{Q. E. D.}$

CASE 8. Of converging rays passing out of a denser into a rarer medium thro' a convex surface of the denser, so as to diverge afterwards.

DEM. Let GB and PD be the incident rays tending towards A, and produce FB to L. Then as AB in the last Case was refracted into BF, GB will in this be refracted into BL, for the reasons already given, having F for its focal point. Therefore, &c.  $\text{Q. E. D.}$

CASE 9. Of diverging rays passing out of a denser into a rarer medium thro' a concave surface of the denser, in such a manner as to continue diverging.

DEM. Let AB, AD (fig. 2.) be two rays passing out of a denser into a rarer medium, through the concave surface DB, whose centre of concavity is C. Draw CB, produce it to K, and let BL be the re-

fracted ray; produce BL back to F, and draw FG parallel to CB meeting BC produced in G. Then will ABC be the angle of incidence, of which FB being opposite to its alternative and equal angle FGB, may be considered as the sine. The refracted angle is LBK, or its equal CBF; of which BG, being opposite to its complement to two right ones BFG, is the sine. Now BF is to BG in the compound ratio of BF to BA and of BA to EG: but BF is to BA as DF to DA; and because of the parallel lines CB and FG, the triangles BCA, AGF, are similar: therefore BA is to AG as CA to AF, and consequently BA is to BG as CA to CF. Therefore, &c.  $\text{Q. E. D.}$

CASE 10. Of converging rays passing out of a denser into a rarer medium through a convex surface of the denser, in such manner as to continue converging.

DEM. Let HB, MD, be the incident rays tending towards the point A. Then will the oblique ray HB, for the reasons already given, be refracted in BF. Therefore, &c.  $\text{Q. E. D.}$

CASE 11. Of diverging rays passing out of a rarer into a denser medium through a concave surface of the denser.

DEM. Let AB, AD (fig. 3.) be the incident rays passing out of a rarer into a denser medium, through the concave surface BD, whose centre of convexity is C, and supposing the line CB drawn and produced to K, the refracted ray BL drawn and produced back to F, and also FG drawn parallel to CB, ABC will be the angle of incidence; of which FB, being opposite to its complement to two right ones BCF, is the sine. The angle of refraction will be LBK, or its equal FBC; of which BG, being opposite to its equal and alternate one BFG, is the sine. Now FB is to BG in the compound ratio of FB to BA and of BA to BG. But (BD vanishing) FB is to BA as FD to DA, and because of the parallel line FG and CB, BA is to BG as CA to CF. Therefore, &c.  $\text{Q. E. D.}$

CASE 12. Of converging rays passing out of a rarer into a denser medium through a convex surface of the denser.

DEM. Let HB, MD, be the incident rays tending towards A the radiant point in the last case; then, as was explained above, BF will be the refracted ray. Therefore, &c.  $\text{Q. E. D.}$

CASE 13. Of rays passing out of a rarer into a denser medium from a point between the centre of convexity and the surface.

DEM. Let AB, AD (fig. 4.) be two rays passing out of a rarer into a denser medium from the point A, which let be posited between C the centre of convexity and the refracting surface BD; through B draw CK, and let BL be the refracted ray; produce BL back to F, and draw FG parallel to BC. Then will ABC be the angle of incidence; of which BF, being opposite to its complement to two right ones BGF, is the sine. LBK will be the angle of refraction, or its equal FBC; of which BG, being opposite to its alternate and equal one BFG, is the sine. But, as before, BF is to BG in a compound ratio of BF to BA and of BA to BG; and (BD vanishing) BF is to BA as DF to DA, and because the lines CB and FG are pa-



Of Refraction.

of Refraction.

parallel, BA is to BG as CA to CF. Therefore, &c. *Q. E. D.*

CASE 14. Of rays passing out of a denser into a rarer medium towards a point between the centre of convexity and the surface.

DEM. Let the incident rays be MD, HB, tending towards A, from whence the other proceeded in the last case. Then, as in that case the refracted ray BL being produced back passed through F, in this the refracted ray itself, for the like reasons as were given in the foregoing cases, will pass through that point. Therefore, &c. *Q. E. D.*

CASE 15. Of rays passing out of a rarer into a denser medium from a point between the centre of convexity and the surface.

Plate CCIX.

DEM. Let AB, AD (fig. 5.) be two diverging rays passing out of a denser into a rarer medium thro' the refracting surface BD, whose centre of convexity is C, a point beyond that from whence the rays flow. Through B draw CK, and let BL be the refracted ray; produce it back to F, and draw FG parallel to BC, meeting BA produced in G. ABC will be the angle of incidence; of which BF, being opposite to its alternate and equal angle BGF, is the sine. The angle of refraction is L BK, or its equal FBC; of which BG, being opposite to its complement to two right ones BFG, is the sine. But BF is to BG in the compound ratio of BF to BA and of BA to BG; and (BD vanishing) BF is to BA as DF to DA; and because of the parallel lines CB and GF, the triangles AFG and ABC are similar. BA therefore is to AG, as CA to AF; consequently BA is to BA and AG together, that is, to BG, as CA is to CA and AF together, that is, to CF; and therefore the focal distance, &c. *Q. E. D.*

CASE 16. Of rays passing out of a denser into a rarer medium towards a point between the centre of convexity and the surface.

DEM. Let HB, MD, be the incident rays having for their imaginary focus the point A, which was the radiant in the last case; and let C the centre of convexity of the refracting surface be posited beyond this point. Then will HB, for the reasons already given, be refracted into BF, having the point F for its real focus, which was the imaginary one of the diverging rays AB, AD, in the former case. Therefore, as before, the ratio compounded of that which the focal distance bears to the distance of the imaginary focus of the incident rays, and of that which the distance between the same imaginary focus and the centre bears to the distance between the centre and the focus, is equal to the ratio which the sine of the angle of incidence bears to the sine of the angle of refraction. *Q. E. D.*

The first term in the foregoing proportion (viz. that in proposition 3d) being always an unknown quantity, those who are not well versed in the use of such proportions, may think it impossible to investigate the focal distance of any refracting surface by it, we shall therefore exemplify in the following instance, by which the manner of doing it in all others will clearly be understood. *V. g.* Let it be required to determine the focal distance of diverging rays passing out of air into glass through a convex surface; and let the distance of the radiant point be 20, and the radius of

convexity be 5: now, because we must make use of the focal distance before we know it, let that be expressed by some symbol or character as  $x$ : Then, because by the aforesaid proposition the ratio compounded of that which the focal distance bears to the distance of the radiant point (that is, in this supposition, of  $x$  to 20), and of the ratio which the distance of the same radiant point from the centre bears to the distance between the centre and the focus (in this case, of 25 to  $x-5$ ), is equal to the ratio which the sine of the angle of incidence bears to the sine of the angle of refraction (that is, of 17 to 11), we shall have, in the instance before us, the following proportion, viz.

$x : 20$  } : : 17 : 11; and compounding them into

$25 : x-5$  } : : 17 : 11; and multiplying them into one, which is done by multiplying the two first parts together, we have  $25x - 100 = 1700 : 17 : 11$ ; and multiplying the extreme terms and middle terms together  $340x - 1700 = 275x$ , which equation after due reduction gives  $x = \frac{1700}{85}$ .

In some cases which might have been put, the quantity 65 would have been negative; and then the quotient arising from 1700, divided by that, would have been too: that is,  $x$  the focal distance would have been negative; in which case, the focus must have been taken on the contrary side of the surface to that on which it was supposed to fall in stating the problem; that is, it must have been taken on the same side with the radiant point; for in calling the distance between the centre and the focus  $x-5$ , it was supposed the focus would fall on the same side with the centre, or on that which is opposite to the radiant point; because otherwise that distance must have been expressed by  $x+5$ ; as any one may see by inspection of the 13th or 14th figure, in which the focus of diverging rays entering a convex surface, is supposed to fall on the same side with the radiant point.

In like manner as this problem was performed, a general theorem may be raised to solve it in all cases whatsoever, by using characters instead of figures; as every one who is not unacquainted with algebraic operations very well knows.

See this done, and applied to the passage of rays through the surface of lenses, in the following section.

A method of determining the point which a ray, entering a spherical surface at any given distance from the vortex of it, converges to, or diverges from, after refraction at the same. *From the Appendix to Molineux's Dioptrics.*

“To find the focus of any parcel of rays diverging from, or converging to, a given point in the axis of a spherical lens [surface], and inclined thereto under the same angle; the ratio of the sines in refraction being known.

“Let GL (fig. 6.) be the lens, P any point in its surface, V the pole [vertex] thereof, C the centre of the sphere whereof it is a segment, O the object or point in the axis to or from which the rays do proceed, OP a given ray; and let the ratio of refraction be as  $r$  to  $s$ ; make CR to CO as  $s$  to  $r$  for the immersion of a ray, or as  $r$  to  $s$  for the emersion, (that is, as the sines of the angles in the medium which the

Of

Retraction.

ray enters, to their corresponding foci in the medium out of which it comes); and laying CR from C towards O, the point R shall be the same for all the rays of the point O. Then draw the radius PC (if need be) continued, and with the centre R and distance OP sweep a touch of an arch, intersecting PC in Q; the line QR being drawn shall be parallel to the refracted ray, and PF being made parallel thereto shall intersect the axis in the point F; which is the focus sought. Or make it as  $CQ : CP :: CR : CF$ , and CF shall be the distance of the focus from the centre of the sphere.

“DEM. Let fall the perpendiculars PX on the axis, CY on the given ray, and CZ on the refracted ray. By the construction QF and PR are parallel, whence the triangles QRC and PFC are similar, and CR to QR, as CF to PF; that is, CR to OP, as CF to PF. Now  $CR : OP :: CZ : PX$  ob *similia triang.*; whence  $CR : OP :: CZ : PX$ , and  $CR : CZ :: OP : PX$ . Again, CR is to CO as the sines of refraction by construction; that is, as  $s$  to  $r$ , or  $r$  to  $s$ ; and as CR to CZ, so  $(CO =) \frac{r}{s}$  or  $\frac{s}{r} CR$  to  $\frac{r}{s}$  or  $\frac{s}{r} CZ$ ; and so is PO to PX: But as PO to PX, so CO to CY.

Ergo,  $CY = \frac{r}{s}$  or  $\frac{s}{r} CZ$ ; that is, CY to CZ is as the sines of refraction; but CY is the sine of the angle of incidence, and CZ of the refracted angle. Ergo constat *propositio.*—

“Hitherto we have considered only oblique rays; it now remains to add something concerning rays parallel to the axis: in this case the point O must be considered as infinitely distant, and consequently OP, OC, and CR are all infinite: and OP and OC are in this case to be accounted as always equal, (since they differ but by a part of the radius of the sphere GPVL, which is no part of either of them): wherefore the ratio of CR to OP will be always the same, *viz.* as  $s$  to  $r$  for immersing rays, and as  $r$  to  $s$  for those that emerge. And by this proposition CF is to PF in the same ratio. It remains therefore to shew on the base CP how to find all the triangles CPF, wherein CF is to PF in the ratio given by the degree of refraction. This problem has been very fully considered by the celebrated Dr Wallis in his late treatise of Algebra, p. 258, to which we refer; but we shall here repeat the construction thereof. (See fig. 7. 8.)

“Let GPVL be a lens, VC or PC the radius of its sphere, and let it be required to find all the points  $f, f$ , such as  $Cf$  may be to  $Pf$  in the given ratio of  $s$  to  $r$  for immersing rays, or as  $r$  to  $s$  for the emerging. Divide CV in K, and continue CV to F, that CK may be to VK, and CF to VF, in the proposed ratio. Then divide KF equally in the point  $a$ , and with that centre sweep the circle KFK; this circle being drawn, gives readily all the foci of the parallel rays OP, OP. For having continued CP till it intersect the circle in F, PF shall be always equal to Vf, the distance of the focus of each respective parcel of rays OP from the vertex or pole of the lens.

“To demonstrate this, draw the prick'd line VF, and by what is delivered by Dr Wallis in the above-cited place, VF and CF will be always in the same proposed ratio. Again, V $f$  being made equal to PF, CF and Cf will be likewise equal, as are CP, VC;

and the angles PCf, VCF, being *ad verticem*, are also equal: Wherefore VCF will be equal to VF, and consequently Cf to Pf in the same ratio as CF to VF; whence, and by what foregoes, the points  $f, f$ , are the several respective foci of the several parcels of rays OP, OP. Q. E. D.

## § 2. Of Glasses.

GLASS may be ground into eight different shapes at least, for optical purposes, *viz.*

1. A *plane-glass*, which is flat on both sides, and of equal thickness in all its parts, as A. Fig. 9.
2. A *plano-convex*, which is flat on one side, and convex on the other, as B.
3. A *double-convex*, which is convex on both sides, as C.
4. A *plano-concave*, which is flat on one side, and concave on the other, as D.
5. A *double concave*, which is concave on both sides, as E.
6. A *meniscus*, which is concave on one side, and convex on the other, as F.
7. A *flat plano-convex*, whose convex side is ground into several little flat surfaces, as G.
8. A *prism*, which has three flat sides, and when viewed endwise appears like an equilateral triangle, as H.

Glasses ground into any of the shapes B, C, D, E, F, are generally called *lenses*.

A right line LIK, (fig. 9.) going perpendicularly through the middle of a lens, is called the *axis of the lens*.

A ray of light Gb, (fig. 10.) falling perpendicularly on a plane glass EF, will pass thro' the glass in the same direction  $bi$ , and go out of it into the air in the same right course *ih*.

A ray of light AB, falling obliquely on a plane glass, will go out of the glass in the same direction, but not in the same right line: for in touching the glass, it will be refracted in the line BC; and in leaving the glass, it will be refracted in the line CD.

A ray of light CD, (fig. 11.) falling obliquely on the middle of a convex glass, it will go forward in the same direction DE, as if it had fallen with the same degree of obliquity on a plane glass; and will go out of the glass in the same direction with which it entered: for it will be equally refracted at the points D and E, as if it had passed through a plane surface. But the rays CG and CI will be fo refracted, as to meet again at the point F. Therefore, all the rays which flow from the point C, so as to go through the glass, will meet again at F; and if they go farther onward, as to L, they cross at F, and go forward on the opposite sides of the middle ray CDEF, to what they were in approaching it in the directions HF and KF.

When parallel rays, as ABC, (fig. 12.) fall directly upon a plano-convex glass DE, and pass through it, they will be fo refracted, as to unite in a point  $f$  behind it: and this point is called the *principal focus*; the distance of which, from the middle of the glass, is called the *focal distance*, which is equal to twice the radius of the sphere of the glass's convexity. And,

When parallel rays, as ABC, (fig. 13.) fall directly upon

Of Refraction.

Of Refraction.

Plate CCIX.

upon a glass DE, which is equally convex on both sides, and pass through it; they will be so refracted, as to meet in a point or principal focus  $f$ , whose distance is equal to the radius or semidiameter of the sphere of the glass's convexity. But if a glass be more convex on one side than the other, the rule for finding the focal distance is this: As the sum of the semidiameters of both convexities is to the semidiameter of either, so is double the semidiameter of the other to the distance of the focus. Or divide the double product of the radii by their sum, and the quotient will be the distance sought.

Since all those rays of the sun which pass through a convex glass are collected together in its focus, the force of all their heat is collected into that part; and is in proportion to the common heat of the sun, as the area of the glass is to the area of the focus. Hence we see the reason why a convex glass causes the sun's rays to burn after passing through it.

All these rays cross the middle ray in the focus  $f$ , and then diverge from it, to the contrary sides, in the same manner  $FfG$ , as they converged in the space  $DfE$  in coming to it.

If another glass FG, of the same convexity as DE, be placed in the rays at the same distance from the focus, it will refract them so, as that, after going out of it, they will be all parallel, as  $abc$ ; and go on in the same manner as they came to the first glass DE, thro' the space ABC; but on the contrary sides of the middle ray  $Bfb$ : for the ray  $ADF$  will go on from  $f$  in the direction  $fGa$ , and the ray  $CEf$  in the direction  $fEc$ ; and so of the rest.

The rays diverge from any radiant point, as from a principal focus: Therefore if a candle be placed at  $f$ , in the focus of the convex glass FG, the diverging rays in the space  $FfG$  will be so refracted by the glass, as that, after going out of it, they will become parallel, as shewn in the space  $cba$ .

If the candle be placed nearer the glass than its focal distance, the rays will diverge after passing thro' the glass more or less as the candle is more or less distant from the focus.

If the candle be placed farther from the glass than its focal distance, the rays will converge after passing thro' the glass, and meet in a point, which will be more or less distant from the glass as the candle is nearer to or farther from its focus: and where the rays meet, they will form an inverted image of the flame of the candle; which may be seen on a paper placed in the meeting of the rays.

Hence, if any object ABC (fig. 15.) be placed beyond the focus F of the convex glass  $def$ , some of the rays which flow from every point of the object, on the side next the glass, will fall upon it; and after passing through it, they will be converged into as many points on the opposite side of the glass, where the image of every point will be formed, and consequently the image of the whole object, which will be inverted. Thus, the rays  $Ad, Ae, Af$ , flowing from the point A, will converge in the space  $daf$ , and by meeting at  $a$ , will there form the image of the point A. The rays  $Bb, Be, Bf$ , flowing from the point B, will be united at  $b$  by the refraction of the glass, and will there form the image of the point B. And the rays  $Cd, Ce, Cf$ , flowing from the point C, will be united at  $c$ , where

they will form the image of the point C. And so of all the other intermediate points between A and C. The rays which flow from every particular point of the object, and are united again by the glass, are called pencils of rays.

If the object ABC be brought nearer to the glass, the picture  $abc$  will be removed to a greater distance. For then more rays flowing from every single point, will fall more diverging upon the glass; and therefore cannot be so soon collected into the corresponding points behind it. Consequently, if the distance of the object ABC (fig. 16.) be equal to the distance  $eB$  of the focus of the glass, the rays of each pencil will be so refracted by passing through the glass, that they will go out of it parallel to each other; as  $dI, eH, fb$ , from the point C;  $dG, eK, fD$ , from the point B; and  $dK, eE, fL$ , from the point A: and therefore, there will be no picture formed behind the glass.

If the focal distance of the glass, and the distance of the object from the glass, be known, the distance of the picture from the glass may be found by this rule, viz. Multiply the distance of the focus by the distance of the object, and divide the product by their difference; the quotient will be the distance of the picture.

The picture will be as much bigger or less than the object, as its distance from the glass is greater or less than the distance of the object. For, as  $Be$  (fig. 15.) is to  $eB$ , so is  $AC$  to  $ca$ . So that if ABC be the object,  $cba$  will be the picture; or if  $cba$  be the object, ABC will be the picture.

For determining the progress of the rays after refraction by any lens, whatever be its form or matter, Mr. Rowning gives the following method. "Suppose GH (fig. 14.) to be a given lens, and E a point in its axis from whence the diverging rays EL, &c. fall upon the lens, AL, the radius of the first convexity, and CK that of the second; let LKf be the direction of the diverging ray EL after its refraction at the first surface, and KF its direction after refraction at both. Then will  $f$  be the focus of the rays after their first refraction, and F the point they will meet in after both. Let BD be the thickness of the lens, and let the proportion which the sine of the angle of incidence bears to the sine of the angle of refraction be expressed by the ratio of I to R. Call EB,  $d_1$ ; BD,  $t_1$ ; AB,  $r_1$ ; CD,  $s_1$ ; Bf,  $x_1$ ; DF,  $y_1$ : Now, to find  $f$  their focus after refraction at L where they enter the first surface of the lens, comes under the third proposition abovementioned: according to which the ratio compounded of  $x$ , the focal distance sought, to  $d_1$ , the distance of the radiant point; and of  $d+r$ , the distance between the same point and the centre, to  $x-r$ , the distance between the centre and the focus, is as I to R; compounding these two ratios therefore (that is, multiplying them together) we have  $dx+rx:dx-dr::I:R$ ; which proposition being converted into an equation, and duly reduced, gives  $x = \frac{Idr}{Id-Rd-RR}$ .

Thus having found the distance Bf, and consequently the point  $f$ , to which the rays converge from L, we must proceed to find F, that to which they will converge after having passed through K, where they suffer

114  
How to find the focus of any lens.

a second refraction: this comes under the same proposition. But, if we would use the same letters as before, to express the proportion which the sine of the angle of incidence bears to that of the angle of refraction, they must be put one for the other; because, when rays pass out of a denser into a rarer medium, the sine of the angle of incidence bears the same proportion to the sine of the angle of refraction, that the sine of the angle of refraction does to the sine of the angle of incidence, when they pass out of a rarer into a denser. This being observed, by the aforesaid proposition, we shall have the ratio compounded of  $y$ , the focal distance,

to  $\frac{Idr}{Id-Rd-Rr}$ , the imaginary focus in the incident rays, and of  $\frac{Idr}{Id-Rd-Rr}$ , the distance between the imaginary focus and the centre, to  $y+r$ , the distance between the centre and the focus, as R to I. Which equation, if we reduce the mixed quantities

$\frac{Idr}{Id-Rd-Rr}$ , and  $\frac{Idr}{Id-Rd-Rr}$ , into improper fractions, will stand thus:

$$y : \frac{Idr - Idt + Rdt + Rrt}{Id - Rd - Rr} \text{ and } \frac{Idr}{Id - Rd - Rr} :: R : I.$$

$$\frac{Idr - Idt + Rdt + Rrt + Ids - Rds - Rrs}{Id - Rd - Rr} : y + r$$

And, compounding these ratios, we have  $\frac{Idr - Idt + Rdt + Rrt + Ids - Rds - Rrs}{Id - Rd - Rr} : \frac{Idr - Idt + Rdt + Rrt + Ids - Rds - Rrs}{R} :: R : I.$

And throwing out the two equal denominators  $Id - Rd - Rr$ , and  $Id - Rd - Rr$ , and multiplying extremes together and means together, we have  $IIdr - IIdt + IRdt + IRrt + IIdy - IRds - IRrs = IRdr - IRdt + IRrdt + IRrt + IRds - IRds + RRdt + RRrt$  ; which equation being reduced, gives  $y = \frac{IRds - IRdt + RRdt + RRrt}{IIdr - IIdt + IRdt + IRrt + IIdy - IRds - IRrs - IRdr - RRdt - RRrt}$

This theorem may be applied to all cases whatever; even to plane surfaces *mutatis mutandis*, *v. g.* the radius of a concave surface being negative (as lying the contrary way) with respect to that of a convex, and the radius of a plain surface being an infinite line. If we would apply this theorem to a concave surface, we must change all the signs of those members wherein the symbol expressing the radius of that surface occurs; and if to a plane surface, all the members which involve the radius must be considered as infinite quantities: that is, all, except them, must be struck out of the equation as nothing. So, likewise, if we would have it extend to other rays besides diverging ones, the point where converging rays would meet, lying on the contrary side to that from whence the diverging ones were supposed to flow, its distance must be made negative; and the distance where parallel rays meet being infinite, it is only changing the signs of all those members in which  $d$  is found, if the rays are supposed converging; or making those members infinite, in case the rays are supposed parallel; which is done by striking out all the rest, as bearing no propor-

tion to them.

§ 3. Of Vision.

HAVING described how the rays of light, flowing from objects, and passing through convex glasses, are collected into points, and form the images of the objects; it will be easy to understand how the rays are affected by passing through the humours of the eye, and are thereby collected into innumerable points on the bottom of the eye, and thereon form the images of the objects which they flow from. For, the different humours of the eye, and particularly the crystalline humour, are to be considered as a convex glass; and the rays in passing through them to be affected in the same manner as in passing through a convex glass. A description of the coats and humours, &c. has been given at large in anatomy: but for the reader's convenience in this place, we shall repeat in a few words as much of the description as will be sufficient for our present purpose.

The eye is nearly globular. It consists of three Plate coats and three humours. The part DHHG of the CGX. outer coat, is called the *sclerotica*; the rest, DEFG, the <sup>15</sup> *cornea*. Next within this coat is that called the *choroides*, which serves as it were for a lining to the other, and joins with the iris, *mn, m*. The iris is <sup>15</sup> Description of the eye. composed of two sets of muscular fibres; the one of a circular form, which contracts the hole in the middle called the *pupil*, when the light would otherwise be too strong for the eye; and the other of radial fibres, tending every where from the circumference of the iris towards the middle of the pupil; which fibres, by their contraction, dilate and enlarge the pupil when the light is weak, in order to let in the more of its rays. The third coat is only a fine expansion of the optic nerve *L*, which spreads like net-work all over the inside of the choroides, and is therefore called the *retina*; upon which are painted (as it were) the images of all visible objects, by the rays of light which either flow or are reflected from them.

Under the cornea is a fine transparent fluid like water, which is therefore called the *aqueous humour*. It gives a protuberant figure to the cornea, fills the two cavities *mm* and *nn*, which communicate by the pupil *P*; and has the same limpidity, specific gravity, and refractive power, as water. At the back of this lies the crystalline humour *II*, which is shaped like a double convex glass; and is a little more convex on the back than the fore part. It converges the rays, which pass through it from every visible object to its focus at the bottom of the eye. This humour is hard jelly, and exceeds the specific gravity of water in the proportion of 11 to 10. It is inclosed in a fine transparent membrane, from which proceed radial fibres *oo*, called the *ligamentum ciliare*, all around its edge; and join to the circumference of the iris.

At the back of the crystalline, lies the vitreous humour *KK*, which is transparent like glass, and is largest of all in quantity, filling the whole orb of the eye, and giving it a globular shape. It is much of a consistence with the white of an egg, and very little exceeds the specific gravity and refractive power of water.

As every point of an object ABC, (*ibid.*) sends out

Of Refraction.

Of Refraction.

out runs in all directions, some rays, from every point on the side next the eye, will fall upon the cornea between E and F; and by passing on thro' the humours and pupil of the eye, they will be converged to as many points on the retina or bottom of the eye, and will thereon form a distinct inverted picture *cba* of the object. Thus, the pencil of rays *qr*, that flows from the point A of the object, will be converged to the point *a* on the retina; those from the point B will be converged to the point *b*; those from the point C will be converged to the point *c*; and so of all the intermediate points; by which means the whole image *abc* is formed, and the object made visible: altho' it must be owned, that the method by which this sensation is carried from the eye by the optic nerve to the common sensory in the brain, and there discerned, is above the reach of our comprehension.

But that vision is effected in this manner, may be demonstrated experimentally. Take a bullock's eye whilst it is fresh; and having cut off the three coats from the back part, quite to the vitreous humour, put a piece of white paper over that part, and hold the eye towards any bright object, and you will see an inverted picture of the object upon the paper.

116

Why we see objects upright.

Since the image is inverted, many have wondered why the object appears upright. But we are to consider, 1. That inverted is only a relative term; and, 2. That there is a very great difference between the real object and the means or image by which we perceive it. When all the parts of a distant prospect are painted upon the retina, they are all right with respect to one another, as well as the parts of the prospect itself; and we can only judge of an object's being inverted, when it is turned reverse to its natural position with respect to other objects which we see and compare it with.—If we lay hold of an upright stick in the dark, we can tell which is the upper or lower part of it, by moving our hand downward or upward; and know very well that we cannot feel the upper end by moving our hand downward. Just so we find by experience, that upon directing our eyes towards a tall object, we cannot see its top by turning our eyes downward, nor its foot by turning our eyes upward; but must trace the object the same way by the eye to see it from head to foot, as we do by the hand to feel it; and as the judgment is informed by the motion of the hand in one case, so it is also by the motion of the eye in the other.

Plate CCC.

In fig. 2. is exhibited the manner of seeing the same object ABC, by both the eyes D and E at once.

117

Optic nerve becomes invisible upon light.

When any part of the image *cba* falls upon the optic nerve L, the corresponding part of the object becomes invisible. On which account, nature has wisely placed the optic nerve of each eye, not in the middle of the bottom of the eye, but towards the side next the nose; so that whatever part of the image falls upon the optic nerve of one eye, may not fall upon the optic nerve of the other. Thus the point *a* of the image *cba* falls upon the optic nerve of the eye D, but not of the eye E; and the point *c* falls upon the optic nerve of the eye E, but not of the eye D: and therefore, to both eyes taken together, the whole object ABC is visible.

The nearer that any object is to the eye, the larger

is the angle under which it is seen, and the magnitude under which it appears. Thus to the eye D, (fig. 3.) the object ABC is seen under the angle APC; and its image *cba* is very large upon the retina: but to the eye E, at a double distance, the same object is seen under the angle APC, which is equal only to half the angle APC, as is evident by the figure. The image *cba* is likewise twice as large in the eye D, as the other image *cba* is in the eye E. In both these representations, a part of the image falls on the optic nerve, and the object in the corresponding part is invisible.

As the sense of seeing is allowed to be occasioned by the impulse of the rays from the visible object upon the retina of the eye, and forming the image of the object thereon, and that the retina is only the expansion of the optic nerve all over the choroides; it should seem surprising, that the part of the image which falls on the optic nerve should render the like part of the object invisible; especially as that nerve is allowed to be the instrument by which the impulse and image are conveyed to the common-sensory in the brain.

118

That the part of the image which falls upon the middle of the optic nerve is lost, and consequently the corresponding part of the object is rendered invisible, is plain by experiment. For if a person fixes three patches, A, B, C, (fig. 4.) upon a white wall, at the height of the eye, and the distance of about a foot from each other, and places himself before them, shutting the right eye, and directing the left towards the patch C, he will see the patches A and C, but the middle patch B will disappear. Or, if he shuts his left eye, and directs the right towards A, he will see both A and C, but B will disappear; and if he directs his eye towards B, he will see both B and A, but not C. For whatever patch is directly opposite to the optic nerve N, vanishes. This requires a little practice, after which he will find it easy to direct his eye so as to lose the sight of whichever patch he pleases.

Proved by experiment.

This experiment, first tried by M. Mariotte, occasioned a new hypothesis concerning the seat of vision, which he supposed not to be in the retina, but in the choroides. An improvement was afterwards made upon it by M. Picard, who contrived that an object should disappear when both the eyes were kept open. He fastened upon a wall a round white paper, an inch or two in diameter; and by the side of it he fixed two marks, one on the right hand, and the other on the left, each at about 2 feet distance from the paper, and somewhat higher. He then placed himself directly before the paper, at the distance of 9 or 10 feet, and putting the end of his finger over against both his eyes, so that the left-hand mark might be hid from the right eye, and the right-hand mark from the left eye. Remaining firm in this posture, and looking steadily, with both eyes, on the end of his finger, the paper which was not at all covered by it would totally disappear. This, he says, is the more surprising, because, without this particular encounter of the optic nerves, where no vision is made, the paper will appear double, as is the case when the finger is not rightly placed.

119

Dispute concerning the seat of vision.

M. Mariotte observes, that this improvement on

his

his experiment, by M. Picard, is ingenious, but difficult to execute, since the eyes must be considerably strained in looking at any object so near to them as four inches; and proposes another not less surprising, and more easy. Place, says he, on a dark ground, two round pieces of white paper, at the same height, and three feet from one another; then place yourself opposite to them, at the distance of 12 or 13 feet, and hold your thumb before your eyes, at the distance of about eight inches, so that it may conceal from the right eye the paper that is to the left hand, and from the left eye the paper to the right hand. Then, if you look at your thumb steadily with both eyes, you will lose sight of both the papers; the eyes being so disposed, that each of them receives the image of one of the papers upon the base of the optic nerve, while the other is intercepted by the thumb.

M. Le Cat pursued this curious experiment a little farther than M. Mariotte had done. In the place of the second paper, he fixed a large white board, and observed, that at a proper distance he lost sight of a circular space in the centre of it. He also observed the size of the paper which is thus concealed from the sight, corresponding to several distances, which enabled him to ascertain several circumstances relating to this part of the structure of the eye more exactly than had been done before.

The manner in which this curious experiment is now generally made, and which is both the easiest with respect to the eye, and the most indisputable with respect to the fact, is the following. Let three pieces of paper be fastened upon the side of a room, about two feet asunder; and let a person place himself opposite to the middle paper, and, beginning near to it, retire gradually backwards, all the while keeping one of his eyes shut, and the other turned obliquely towards that outside paper which is towards the covered eye, and he will find a situation (which is generally at about five times the distance at which the papers are placed from one another), where the middle paper will entirely disappear, while the two outermost continue plainly visible; because the rays which come from the middle paper will fall upon the retina where the optic nerve is inserted.

It will not surprize any person, even those who are the strongest advocates for the retina being the place at which the pencils of rays are terminated, and consequently the proper seat of vision, that M. Mariotte was led by this remarkable observation to suspect the contrary. He not only did so; but, in consequence of attentively considering the subject, a variety of other arguments in favour of the choroides occurred to him, particularly his observation, that the retina is transparent, as well as the crystalline, and other humours of the eye, which he thought could only enable it to transmit the rays farther; and he could not persuade himself that any substance could be considered as being the termination of the pencils, and the proper seat of vision, at which the rays are not stopped in their progress.

He was farther confirmed in his opinion of the small degree of sensibility in the retina, and of the greater

sensibility of the choroides, by observing that the pupil dilates itself in the shade, and contracts itself in a great light; which involuntary motion, he thought, was a clear proof that the fibres of the iris are extremely sensible to the action of light; and this part of the eye is only a continuation of the choroides (A). He also thought that the dark colour of the choroides was intended to make it more susceptible of the impression of light.

M. Pecquet, in answer to M. Mariotte's observation concerning the transparency of the retina, says, that it is very imperfectly so, resembling only oiled paper, or the horn that is used for lanterns; and besides, that its whiteness demonstrates it to be sufficiently opaque for stopping the rays of light, as much as is necessary for the purpose of vision; whereas, if vision be performed by means of those rays which are transmitted through such a substance as the retina, it must be very indistinct.

As to the blackness of the choroides, which M. Mariotte thought to be necessary for the purpose of vision, M. Pecquet observes, that it is not the same in all eyes, and that there are very different shades of it among the individuals of mankind, as also among birds, and some other animals, whose choroides is generally black; and that in the eyes of lions, camels, bears, oxen, stags, sheep, dogs, cats, and many other animals, that part of the choroides which is the most exposed to light, very often exhibits colours as vivid as those of mother of pearl, or of the iris. He admits that there is a defect of vision at the insertion of the optic nerve; but he thought that it was owing to the blood-vessels of the retina, the trunks of which are so large in that place as to obstruct all vision.

To M. Pecquet's objection, founded on the opacity of the retina, M. Mariotte observes, that there must be a great difference betwixt the state of that substance in living and dead subjects; and as a farther proof of the transparency of the retina, and the power of the choroides beyond it to reflect light, he says, that if a lighted candle be held near to a person's eyes, and a dog, at the distance of eight or ten steps, be made to look at him, he would see a bright light in the dog's eyes, which he thought to proceed from the reflection of the light of the candle from the choroides of the dog, since the same appearance cannot be produced in the eyes of men, or other animals, whose choroides is black.

To M. Pecquet's remark concerning the blood vessels of the retina, M. Mariotte observes, that they are not large enough to prevent vision in every part of the base of the nerve; since the diameter of each of the two vessels occupy no more than  $\frac{1}{8}$  part of it. Besides, if this were the cause of this want of vision, it would vanish gradually, and the space to which it is confined would not be so exactly terminated as it appears to be.

We must add, that M. Pecquet also observed, that notwithstanding the insensibility of the retina at the insertion of the optic nerve when the light is only moderate; yet that luminous objects, such as a bright candle placed at the distance of four or five paces, do

(A) M. Muffchenbroeck says, that in many animals, as the lion, camel, bear, ox, stag, sheep, dog, cat, and many birds, the choroides is not black, but blue, green, yellow, or some other colour. *Introductio*, Vol. II. p. 748.

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not absolutely disappear, in the same circumstances in which a white paper would; for that this strong light may be perceived though the picture fall on the base of the nerve. "I cannot help suspecting, however, (says Dr Priestley), that M. Pecquet did not make this observation with sufficient care. A large candle makes no impression on that part of my eye, though it is by no means able to bear a strong light."

The common opinion was also favoured by the anatomical description of several animals by the members of the French academy, and particularly their account of the sea-calf and porcupine; in both of which the optic nerve is inserted in the very axis of the eye, exactly opposite to the pupil, which was thought to leave no room to doubt, but that in these animals the retina is perfectly sensible to the impression of light at the insertion of the nerve. But this observation may deserve to be reconsidered.

M. De la Hire took part with M. Pecquet, arguing in favour of the retina from the analogy of the senses, in all of which the nerves are the proper seat of sensation. This philosopher, however, supposed that the choroides receives the impressions of images, in order to transmit them to the retina.

M. Perrault also took the part of M. Pecquet against M. Mariotte, and in M. Perrault's works we have several letters that passed between these two gentlemen upon this subject.

This dispute about the immediate instrument of vision was revived upon the occasion of an odd experiment of M. Mery, recorded in the memoirs of the French academy for 1704. He plunged a cat in water, and exposing her eye to the strong light of the sun, observed that the pupil was not at all contracted by it; from which he concluded, that the contraction of the iris is not produced by the action of the light, but by some other circumstance. For he contended that the eye receives more light in this situation than in the open air. At the same time he thought he observed that the retina of the cat's eye was transparent, and that he could see the opaque choroides beyond it; from which he concludes, that the choroides is the substance intended to receive the rays of light, and to be the chief instrument of vision. But M. De la Hire replies to this argument of M. Mery, in a memoir for the year 1709, p. 119; in which he endeavours to shew that fewer rays enter the eye under water, and that in those circumstances it is not so liable to be affected by them. Besides, it is obvious to be remarked, that the cat must be in great terror in this situation; and being an animal that has a very great voluntary power over the muscles of the iris, and being now extremely attentive to every thing about her, she might keep her eye open notwithstanding the action of the light upon it, and though it might be very painful to her. We are informed, that when a cat is placed in a window through which the sun is shining, and consequently her iris nearly closed, if she hear a rustling, like that which is made by a mouse, on the outside of the window, she will immediately open her eyes to their greatest extent, without in the least turning her face from the light.

M. Le Cat took part with M. Mariotte in this controversy, it being peculiarly agreeable to this general hypothesis, viz. that the pia mater, of which the cho-

roides is a production, and not the nerves themselves, is the proper instrument of sensation. He thought that the change which takes place in the eyes of old people (the choroides growing less black with age) favoured his hypothesis, as they do not see with that distinctness with which young persons do. M. Le Cat supposed that the retina answers a purpose similar to that of the scarf-skin, covering the papillæ pyramidales, which are the immediate organ of feeling, or that of the porous membrane which covers the glandulous papillæ of the tongue. The retina, he says, receives the impression of light, moderates it, and prepares it for its proper organ, but is not itself sensible of it.

It must be observed, that M. Le Cat had discovered that the pia mater, after closely embracing and confining the optic nerve at its entrance into the eye, divides into two branches, one of which closely lines the cornea, and at length is lost in it, while the second branch makes what is called the *choroides*, or *uvea*. He also shewed that the sclerotica is an expansion of the dura mater; and he sent dissections of the eye to the royal academy of sciences in 1739, to prove these assertions, and several others which he had advanced in his *Traité des Sens*, that were contrary to the opinions of the celebrated Winflow.

To these arguments in favour of the choroides, alleged by those gentlemen among whom the subject was first discussed, Dr Priestley in his history adds the following that had escaped their notice, but which were suggested to him by his friend Mr Michell.

In order that vision be distinct, the pencils of rays which issue from the several points of any object, must be collected either accurately, or at least very nearly, to corresponding points in the eye, which can only be done upon some uniform surface. But the retina being of a considerable thickness, and the whole of it being uniformly nervous, and at least nearly, if not perfectly, transparent, presents no particular surface; so that, in whatever part of it the pencils be supposed to have their foci, the rays belonging to them will be separated from one another, either before or after they arrive there, and consequently vision would be confused.

If we suppose the seat of vision to be at the nearer surface of the retina, and the images of objects be formed by direct rays, a considerable degree of confusion could not but arise from the light reflected by the choroides, in those animals in which it is white, or coloured. On the other hand, it would be impossible that vision should be performed at this place by light reflected from the choroides, because in many animals it is perfectly black, and reflects no light at all; and yet such animals see even more distinctly than others. And we cannot but suppose that, in whatever manner vision is effected, it is the same in the eyes of all animals.

If the seat of vision be at the farther surface of the retina, and it be performed by direct rays, a white choroides could be of no use; and if it were by reflected rays, a black one could not answer the purpose.

It is likewise an argument in favour of the choroides being the organ of vision, that it is a substance which receives a more distinct impression from the rays of light than any other membrane in any part of the animal system, excepting (and perhaps not excepting) that white cuticle which lies under the scales of fishes; and whereas

whereas the retina is a substance on which the light makes an exceedingly faint impression, and perhaps no impression at all; since light, in passing out of one transparent medium into another immediately contiguous to it, suffers no refraction or reflection, nor are any of the rays absorbed, unless there is some difference in the refracting power of the two media, which probably is not the case between the retina and the vitreous humour, which is in contact with it. And wherever the light is not affected by the medium it falls upon, we can hardly suppose the medium to receive any impression from the light, the action being probably always mutual and reciprocal.

Besides, the retina is so situated, as to be exposed to many rays besides those which terminate in it, and which, therefore, cannot be subservient to vision, if it be performed there. Now this is not the case with the choroides, which is in no shape transparent, and has no reflecting substance beyond it.

It is, moreover, peculiarly favourable to the hypothesis of the seat of vision being in the choroides, that we can then see a sufficient reason for the diversity of its colour in different animals, according as they are circumstanced with respect to vision. In all terrestrial animals, which have occasion to make use of their eyes by night, the choroides is either of a bright white, or of some very vivid colour, which reflects the light very strongly. On this account vision may be performed with less light, but it cannot be with great distinctness, the reflection of the rays doubling their effect; since it must extend over some space, all reflection being made at a distance from the reflecting body. Besides, the choroides in brutes is not in general perfectly white, but a little inclined to blue; and is therefore, probably, better adapted to see by the fainter coloured light, which chiefly prevails in the night; and, we would add, is on the same account more liable to be strongly impressed by the colours to which they are chiefly exposed.

On the other hand, the choroides of birds in general, especially eagles, hawks, and other birds of prey, is black; by which means they are able to see with the greatest distinctness, but only in bright day-light. The owl, however, seeking her food by night, has the choroides white, like that of a cat. Lastly, in the eyes of man, which are adapted to various uses, the choroides is neither so black as that of birds, nor so white as that of those animals who make the greatest use of their eyes in the night.

As to a third hypothesis, which is in effect that of M. De la Hire, which makes both the retina and the choroides equally necessary to vision, and suppose it be performed by the impression of light on the choroides communicated to the retina; Mr Michell observes, that the perceptions can hardly be supposed to be so acute, when the nerves, which are the chief instruments of sensation, do not receive the impressions immediately, but only after they have been communicated to another substance. Besides, it must be more natural to suppose, that, when the principal impression is made upon the choroides, it is communicated to the brain by its own proper nerves, which are abundantly sufficient for the purpose.

The dimensions and precise form of the spot in the eye in which there is no vision, were more accurately

calculated by Daniel Bernoulli, in the following manner. He placed a piece of money O, fig. 1, upon the floor; and then shutting one of his eyes, and making a pendulum to swing, so that the extremity of it might be nearly in the line AO, he observed at what place C it began to be invisible, and where it again emerged into view at A. Raising the pendulum higher and lower, he found other points, as H, N, P, G, B, at which it began to be invisible; and others, as M, L, E, A, at which it began to be visible again; and drawing a curve through them, he found that it was elliptical; and, with respect to his own eye, the dimensions of it were as follows, OC was 23, AC 10, BD 3, DH 13, and EG 14; so that the centre being at F, the greater axis was to the less as 8 to 7.

From these data, the plane on which the figure was drawn being obliquely situated with respect to the eye, he found, that the place in the eye that corresponded to it was a circle, the diameter of which was a seventh part of the diameter of the eye, the centre of it being 27 parts of the diameter from the point opposite to the pupil, a little above the middle. He concludes with observing, that, in order that this space in which there is no vision, may be as small as possible, it was necessary that the nerve should enter the eye perpendicularly, and that both this end, and also its entering the eye at a distance from its axis, are gained by the particular manner in which the two optic nerves unite and become separate again, by crossing one another.

In favour of one of the observations of Mr Michell, concerning the use of the choroides in vision, Dr Priestley observes, that Aquapendente mentions the case of a person at Pisa, who could see very well in the night, but very little or none at all in the daytime. This is also said to be the case with those white people among the blacks of Africa, and the inhabitants of the illiums of America, who, from this circumstance, are called *moon-eyed*. Our author thinks it probable that their choroides is not of a dark colour, as it is in others of the human species; but white, or light coloured, as in those animals which have no occasion for their eyes in the night.

The following considerations in favour of the retina being the proper seat of vision are worthy of remark.

Dr Porterfield observes, that the reason why there is no vision at the entrance of the optic nerve into the eye, may be, that it wants that softness and delicacy, which it has when it is expanded upon the choroides; and that, in those animals in which that nerve is inserted in the axis of the eye, it is observed to be equally delicate, and therefore probably equally sensible, in that place as in any other part of the retina. In general, the nerves, when constricted by their coats, have but little sensibility, in comparison of what they are endued with when they are distended of them, and unfolded in a soft and pulpy substance.

Haller observes, that the choroides cannot be the universal instrument of vision, because that sometimes in men and birds, but especially in fishes, it is covered internally with a black mucus, through which the rays cannot penetrate. This writer speaks of a fibrous membrane in the retina distinct from its pulpy substance. On these fibres, he conjectures, that the images of objects are painted.

M. De la Hire's argument in favour of the retina, from



Of Refraction.

from the analogy of the senses, is much strengthened by considering that the retina is a large nervous apparatus, immediately exposed to the impression of light; whereas the choroides receives but a slender supply of nerves, in common with the sclerotics, the conjunctiva, and the eyelids, and that its nerves are much less exposed to the light than the naked fibres of the optic nerve. Indeed, from anatomical considerations, one might imagine that any other part of the body was as sensible of the impression of light, as the choroides.

That the optic nerve is of principal use in vision is farther probable from several phenomena attending some of the diseases in which the sight is affected. When an amaurosis has affected one eye only, the optic nerve of that eye has been found manifestly altered from its found state. Dr Pricllely was present when Mr Hey examined the brain of a young girl, who had been blind of one eye, and saw that the optic nerve belonging to it was considerably smaller than the other; and he informed him, that, upon cutting into it, he found it to be much harder, and cineritious. Morgagni, indeed, mentions two cases, in one of which he found the optic nerves smaller than usual, and of a cineritious colour, when, upon inquiry, he was informed that the person had not been blind, though there might have been some defect in the sight of one of the eyes. In the other case, only one of the optic nerves was affected in that manner, and the eye itself was in other respects very perfect. Here, also, he was expressly told that the person was not blind of that eye: but it appears that he himself had not been acquainted with the persons whom he dissected; and there have been many cases of persons being blind of one eye, without knowing it themselves, for a considerable time.

Moreover, as the optic nerve is solely spent in forming the retina, so no function of the eye, not immediately subservient to vision, is affected by an amaurosis. On the contrary, those nerves which go to the choroides are found to retain, in this disease, their natural influence. The iris will contract in a recent gutta serena of one eye, if the other remains sound, and is suddenly exposed to a strong light. The sclerotic, conjunctiva, and eyelids, which receive their nerves from the same branches as the choroides retain their sensibility in this disorder.

The manner in which persons recover from an amaurosis, favours the supposition of the seat of vision being in the retina; since those parts which are the most distant from the insertion of the nerve recover their sensibility the soonest, being, in those places, the most pulpy and softest; whereas there is no reason to think that there is any difference in this respect in the different parts of the choroides. Mr Hey has been repeatedly informed, by persons labouring under an imperfect amaurosis, or gutta serena, that they could not, when looking at any object with one eye, see it so distinctly when it was placed directly opposite to the pupil, as when it was situated somewhat obliquely. And those persons whom he had known to recover from a perfect amaurosis, first discovered the objects whose images fell upon that part of the retina which is at the greatest distance from the optic nerve.

We shall conclude these remarks with observing,

1

Of Refraction.

that, if the retina be as transparent as it is generally represented to be, so that the termination of the pencils must necessarily be either upon the choroides, or some other opaque substance interposed between it and the retina, the action and reaction occasioned by the rays of light being at the common surface of this body and the retinas, both these mediums (supposing them to be equally sensible to the impression of light) may be equally affected; but the retina, being naturally much more sensible to this kind of impression, may be the only instrument by which the sensation is conveyed to the brain, though the choroides, or the black substance with which it is sometimes lined, may also be absolutely necessary for the purpose of vision. Indeed, when the reflection of the light is made at the common boundary of any two mediums, it is with no propriety that this effect is ascribed to one of them rather than the other; and the strongest reflections are often made back into the densest mediums, when they have been contiguous to the rarest, or even to a vacuum. This is not far from the hypothesis of M. De la Hire, and will completely account for the entire defect of vision at the insertion of the optic nerve.

Vision is distinguished into *bright and obscure, distinct and confused*.—It is said to be bright, when a sufficient number of rays enter the pupil at the same time; obscure, when too few. It is distinct when each pencil of rays is collected into a focus exactly upon the retina; *confused*, when they meet before they come at it, or when they would pass it before they meet; for, in either of these last cases, the rays flowing from different parts of the object, will fall upon the same part of the retina, which must necessarily render the image confused and indistinct.—Now, that objects may appear with a due brightness, whether more or fewer rays proceed from them, we have a power of contracting or dilating the pupil by means of the muscular fibres of the iris, in order to take in more or fewer rays as occasion requires. But this power has its limits. In some animals it is much greater than in others; particularly in such as are obliged to seek their food by night, as well as by day, as in cats, &c.

That the rays may be collected into points exactly upon the retina, that is, that objects may appear distinct, whether they be nearer or farther off, *i. e.* different distances, whether the rays proceeding from them diverge more or less, we have a power of contracting or relaxing the ligamenta ciliaria, and thereby altering the form of the crystalline humour, and with it the focal distance of the rays. Thus, when the object we view is far off, and the rays fall upon the pupil with a very small degree of divergency, we contract the *ligamenta ciliaria*, which, being concave towards the vitreous humour, do thereby compress it more than otherwise they would do: by this means it is made to press harder upon the backside of the crystalline humour, which is thereby rendered flatter; and thus the rays proceed farther before they meet in a focus, than otherwise they would have done. Add to this, that we dilate the pupils of our eyes (unless in cases where the light is so strong that it offends the eye), and thereby admit rays into them that are more diverging than those which would otherwise enter. And, when the rays come from an object that is very near, and there-

Of Refraction.

force diverge too much to be collected into their respective foci upon the retina; by relaxing the *ligamenta ciliaria*, we give the crystalline a more convex form, by which means the rays are made to suffer a proportionably greater degree of refraction in passing through it. Some philosophers are of opinion that we do this by a power of altering the form of the eye; and others, by removing the crystalline forwards or backwards as occasion requires: but neither of these opinions is probable; for the coats of the eye are too hard, in some animals, for the first; and, as to moving the crystalline out of its place, the cavities of the eye seem to be too well filled with the other humours to admit of such removal.

Besides this, in the case above-mentioned, by contracting the pupils of our eyes, we exclude the more diverging rays, and admit only such as are more easily refracted into their respective foci (A). But vision is not distinct at all distances, for our power of contracting and relaxing the *ligamenta ciliaria* is also circumscribed within certain limits.

113  
Of short-sighted and long-sighted people.

In those eyes where the tunica cornea is very protuberant and convex, the rays of light suffer a very considerable refraction at their entrance into the aqueous humour, and are therefore collected into a focus before they fall upon the retina, unless the object be placed very near, so that the rays which enter the eye may have a considerable degree of divergency. People that have such eyes are said to be *parblind*. Now, the nearer an object is to the eye, the greater is the image of it therein, as explained above: these people therefore can see much smaller objects than others, as seeing much nearer ones with the same distinctness; and their sight continues good longer than that of other people, because the tunica cornea of their eyes, as they grow old, becomes plainer, for want of that redundancy of humours with which they were filled before. On the contrary, old men, having the cornea of their eyes too flat for want of a sufficient quantity of the aqueous humour to fill them out, if the rays diverge too much before they enter the eye, they cannot be brought to a focus before they reach the retina; on which account those people cannot see distinctly, unless the object be situated at a greater distance from the eye, than is required for those whose eyes are of a due form. The latter require the assistance of convex glasses, to make them see objects distinctly; the former of concave ones. For if either the cornea *abc* (fig. 5.) or crystalline humour *e*, or both of them, be too flat, as in the eye A, their focus will not be on the retina as at A, where it ought to be, in order to render vision distinct; but beyond the eye, as at *f*. This is remedied by placing a convex glass *gh* before the eye, which makes the rays converge sooner, and imprints the image due on the retina at *d*. Again, if either the cornea, or crystalline humour, or both of them, be too convex, as in the eye B, the rays that enter it from the object C will be converged to a focus in the vitreous humour, as at *f*; and by diverging from thence to the retina, will form a very confused image thereon; and so, of course, the observer will have as confused a view of the object as if his eye had been too

Plate CCX.

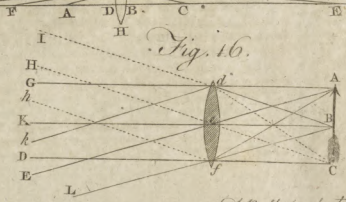
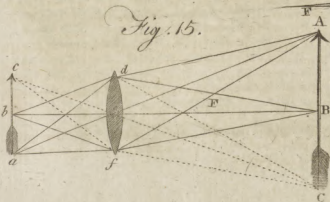
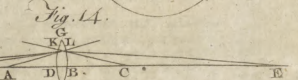
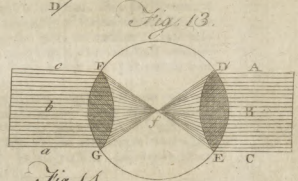
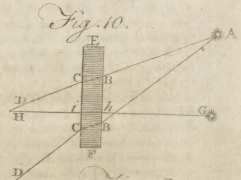
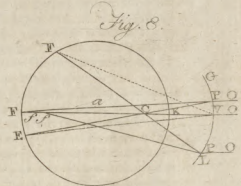
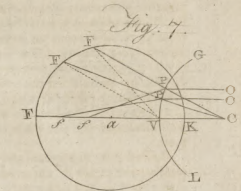
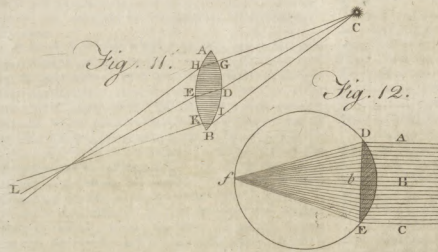
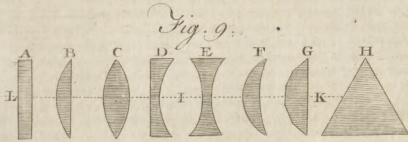
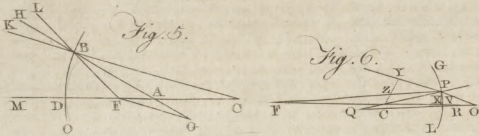
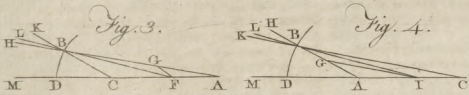
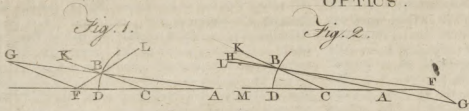
flat. This inconvenience is remedied by placing a concave glass *gh* before the eye; which glass, by causing the rays to diverge between it and the eye, lengthens the focal distance so, that if the glass be properly chosen, the rays will unite at the retina, and form a distinct image of the object upon it.

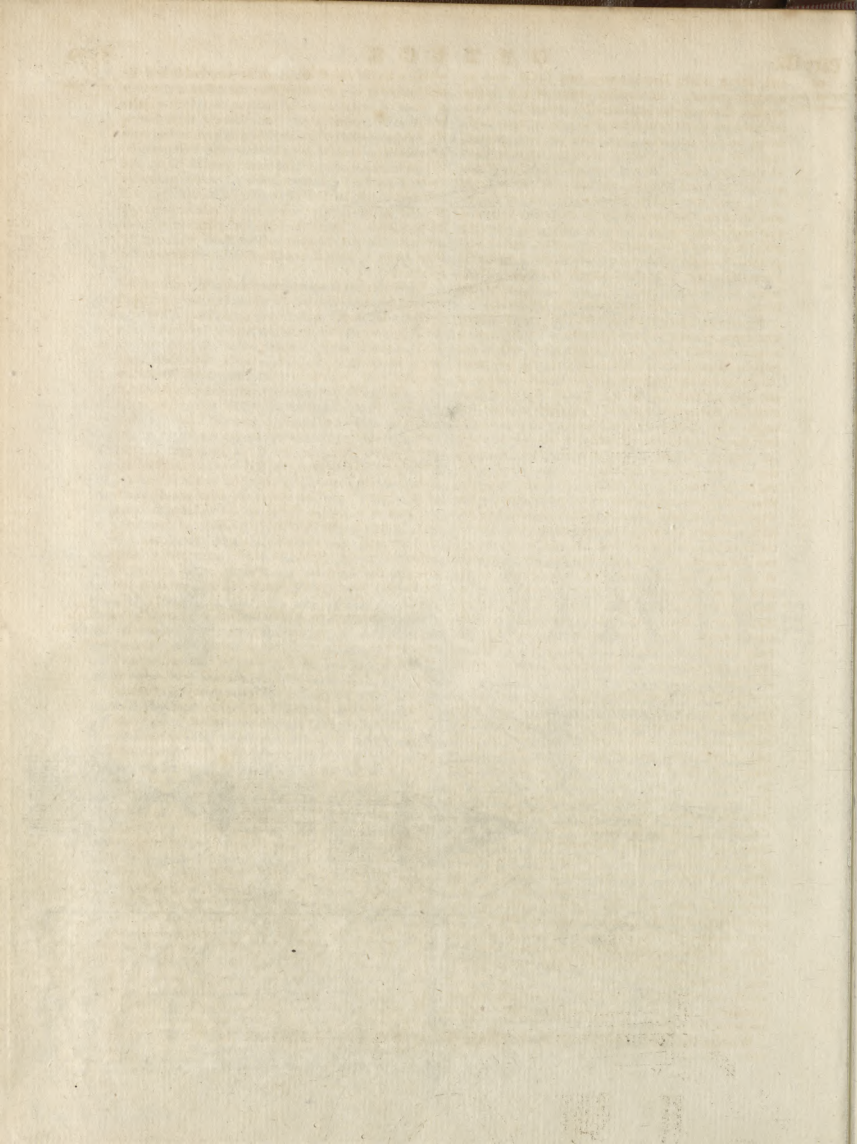
Such eyes as are of a due convexity, cannot see any object distinctly at less distance than six inches; and angle of vision. <sup>114</sup> and angle of vision. There are numberless objects too small to be seen at that distance, because they cannot appear under any sensible angle.—Concerning the least angle under which any object is visible, there was a debate between Dr Hooke and Hevelius. The former asserted, that no object could well be seen if it subtended an angle less than one minute; and, if the object be round, as a black circular spot upon a white ground, or a white circle upon a black ground, it follows, from an experiment made by Dr Smith, that this is near the truth; and from thence he calculates, that the diameter of the picture of such least visible point upon the retina is the 8000th part of an inch; which he therefore calls a *sensible point of the retina*. On the other hand, Mr Courtivron concluded from his experiments, that the smallest angle of vision was 40 seconds. According to Dr Jurin, there are cases in which a much smaller angle than one minute can be discerned by the eye; and in order to throw light upon the subject, he observes, that, in order to our perceiving the impression made by any object upon our senses, it must either be of a certain degree of force, or of a certain degree of magnitude. For this reason a star, which appears only as a lucid point through a telescope, subtending not so much as an angle of one second, is visible to the eye; though a white or black spot, of 25 or 30 seconds, is not to be perceived. <sup>115</sup> Lines can be seen under smaller angles than spots, and why. Also a line of the same breadth with the circular spot will be visible, at such a distance as the spot is not to be perceived at; because the quantity of impression from the line is much greater than from the spot; and a longer line is visible at a greater distance than a shorter one of the same breadth. He found by experience, that a silver wire could be seen when it subtended an angle of three seconds and an half; and that a silk thread could be seen when it subtended an angle of two seconds and a half.

This greater visibility of a line than of a spot, seems to arise only from the greater quantity of the impression; but without the limits of perfect vision, our author observes, that another cause concurs, whereby the difference of visibility between the spot and the line is rendered much more considerable. For the impression upon the retina made by the line is then not only much greater, but also much longer than that of the spot; because the faint image, or penumbra, of any one point of the line, when the whole is placed beyond the limits of distinct vision, will fall within the faint image of the next point, and thereby much increase the light that comes from it.

In some cases our author found the cause of indistinct vision to be the unsteadiness of the eye; as our being able to see a single black line upon a white ground, or a single white line upon a black ground, and

(A) Accordingly it is observed, that if we make a small hole with the point of a needle through a piece of paper, and apply that hole close to the eye, making use of it, as it were, instead of a pupil, we shall be able to see an object distinctly through it, though the object be placed within half an inch of the eye.





Of Refraction.

Of Refraction.

and not a white line between two black ones on a white ground. In viewing either of the former objects, if the eye be imperceptibly moved, all the effect will be, that the object will be painted upon a different part of the retina; but, wherever it is painted, there will be but one picture, single and uncompound with any other. But in viewing the other, if the eye fluctuate ever so little, the image of one or other of the black lines will be shifted to that part of the retina which was before possessed by the white line; and this must occasion such a dazzle in the eye, that the white line cannot be distinctly perceived, and distinguished from the black lines; which, by a continual fluctuation, will alternately occupy the space of the white line, whence must arise an appearance of one broad dark line, without any manifest separation.

By trying this experiment with two pins of known diameters, set in a window against the sky light, with a space between them equal in breadth to one of the pins, he found that the distance between the pins could hardly be distinguished when it subtended an angle of less than 40 seconds, though one of the pins alone could be distinguished when it subtended a much less angle. But though a space between two pins cannot be distinguished by the eye when it subtends an angle less than 40 seconds, it would be a mistake to think that the eye must necessarily commit an error of 40 seconds in estimating the distance between two pins when they are much farther from one another. For if the space between them subtend an angle of one minute, and each of the pins subtend an angle of four seconds, which is greater than the least angle the eye can distinguish, it is manifest that the eye may judge of the place of each pin within two seconds at the most; and consequently the error committed in taking the angle between them cannot at the most exceed four seconds, provided the instrument be sufficiently exact. And yet, says he, upon the like mistake was founded the principal objection of Dr Hooke against the accuracy of the celestial observations of Hevelius.

A black spot upon a white ground, or a white spot upon a black ground, he says, can hardly be perceived by the generality of eyes when it subtends a less angle than one minute. And if two black spots be made upon white paper, with a space between them equal in breadth to one of their diameters, that space is not to be distinguished, even within the limits of perfect vision, under so small an angle as a single spot of the same size can be distinguished. To see the two spots distinctly, therefore, the breadth of the space between them must subtend an angle of more than a minute. It would be very difficult, he says, to make this experiment accurately, within the limits of perfect vision; because the objects must be extremely small: but by a rude trial, made with square bits of white paper, placed upon a black ground, he judged, that the least angle under which the interval of two objects could be perceived, was at least a fourth part greater than the least angle under which a single object can be perceived. So that an eye which cannot perceive a single object under a smaller angle than one minute, will not perceive the interval between two such objects under a less angle than 75 seconds.

Without the limits of perfect vision, the distance at

which a single object ceases to be perceivable will be much greater in proportion than the distance at which a space of equal breadth between two such objects ceases to be perceivable. For, without these limits, the image of each of the objects will be attended with a penumbra, and the penumbra of the two near objects will take up part of the space between them, and thereby render it less perceivable; but the penumbra will add to the breadth of the single object, and will thereby make it more perceivable, unless its image be very faint. Upon the same principles he likewise accounts for the radiation of the stars, whereby the light seems to project from them different ways at the same time.

Mr Mayer made many experiments in order to ascertain the smallest angle of vision in a variety of respects. He began with observing at what distance a black spot was visible on white paper; and found, that when it could barely be distinguished, it subtended an angle of about 34 seconds. When black lines were disposed with intervals broader than themselves, they were distinguished at a greater distance than they could be when the objects and the intervals were of an equal breadth. In all these cases it made no difference whether the objects were placed in the shade, or in the strong light of the sun; but when the degrees of light were small, their differences had a considerable effect, though by no means in proportion to the differences of the light. For if an object was illuminated to such a degree as to be just visible at the distance of nine feet, it would be visible at the distance of four feet, tho' the light was diminished above 160 times. It appeared in the course of these experiments, that common day-light is, at a medium, equal to that of 25 candles placed at the distance of one foot from the object.

As an image of every visible object is painted on the <sup>126</sup> retina of each of our eyes, it thence becomes a natural question, Why we do not see every thing double? <sup>126</sup> It was the opinion of Sir Isaac Newton and others, that objects appear single because the two optic nerves unite before they reach the brain. But Dr Porterfield shews, from the observation of several anatomists, that the optic nerves do not mix, or confound their substance, being only united by a close cohesion; and objects have appeared single where the optic nerves were found to be disjointed.

Dr Briggs supposed that single vision was owing to the equal tension of the corresponding parts of the optic nerves, whereby they vibrated, in a synchronous manner. But, besides several improbable circumstances in this account, Dr Porterfield shews that facts do by no means favour it.

To account for this phenomenon, this ingenious writer supposes, that by an original law in our natures, we imagine objects to be situated somewhere in a right line drawn from the picture of it upon the retina, through the centre of the pupil. Consequently, the same object appearing to both eyes to be in the same place, the mind cannot distinguish it into two. In answer to an objection to this hypothesis, from objects appearing double when one eye is distorted, he says the mind mistakes the position of the eye, imagining that it had moved in a manner corresponding to the other, in which case the conclusion would

have

have been just. In this he seems to have recourse to the power of habit, tho' in words he disclaims that hypothesis.

This principle, however, has generally been thought to be sufficient to account for this appearance. Originally, every object making two pictures, one in each eye, is imagined to be double; but, by degrees, we find, that when two corresponding parts of the retina are impressed, the object is but one; but if those corresponding parts be changed, by the distortion of one of the eyes, the object must again appear double as at the first. This seems to be verified by Mr Cheselden; who informs us, that a gentleman, who from a blow on his head had one eye distorted, found every object to appear double; but by degrees the most familiar ones came to appear single again, and in time all objects did so, without any amendment of the distortion. A case similar to this is mentioned by Dr Smith.

On the other hand, Dr Reid is of opinion, that the correspondence of the centres of the two eyes, on which single vision depends, does not arise from custom, but from some natural constitution of the eye and of the mind. He makes several just objections to the case of Mr Foster, recited by Dr Smith and others; and thinks that the case of the young man couched by Cheselden, who saw singly with both eyes immediately upon receiving his sight, is nearly decisive in proof of his supposition. He also found that three young gentlemen, whom he endeavoured to cure of squinting, saw objects singly, as soon as ever they were brought to direct the centres of both their eyes to the same object, though they had never been used to do so from their infancy; and he observes, that there are cases, in which, notwithstanding the fullest conviction of an object being single, no practice of looking at it will ever make it appear so, as when it is seen thro' a multiplying glass.

We are indebted to Dr Jurin for the following curious experiments to determine whether an object seen by both eyes appears brighter than when seen with one only.

He laid a slip of clean white paper directly before him on a table, and applying the side of a book close to his right temple, so as that the book was advanced considerably more forward than his face, he held it in such a manner, as to hide from his right eye that half of the paper which lay to his left hand, while the left half of the paper was seen by both eyes, without any impediment.

Then looking at the paper with both eyes, he observed it to be divided, from the top to the bottom, by a dark line, and the part which was seen with one eye only was manifestly darker than that which was seen with both eyes; and, applying the book to his left temple, he found, by the result of the experiment, that both his eyes were of equal goodness.

He then endeavoured to find to what degree this excess of brightness amounted; and comparing it with the appearance of an object illuminated partly by one candle and partly by two, he was surpris'd to find that an object seen with two eyes is by no means twice as luminous as when it is seen with one only; and after a number of trials, by which he made the proportion less and less continually, he found, that when one

paper was illuminated by a candle placed at the distance of three feet, and another paper by the same candle at the same distance, and by another candle at the distance of 11 feet, the former seen by both eyes, and the latter with one eye only, appeared to be of equal whiteness; so that an object seen with both eyes appears brighter than when it is seen with one only by about a 13th part. But he acknowledges, that is difficult to make this experiment exactly.

He then proceeded to inquire, whether an object seen with both eyes appears any thing larger than when seen with one only; but he concluded that it did not, except on account of some particular circumstances, as in the case of the binocular telescope, and the concave speculum.

M. Du Tour maintains, that the mind attends to no more than the image made in one eye at a time; and produces several curious experiments in favour of this hypothesis, which had also been maintained by Kepler and almost all the first opticians. But, as M. Buffon observes, it is a sufficient answer to this hypothesis, how ingeniously soever it may be supported, that we see more distinctly with two eyes than one; and that when a round object is near us we plainly see more of the surface in one case than in the other. There are, also, other facts, which clearly prove the contrary of what is maintained by M. Du Tour.

With respect to single vision with two eyes, Dr Hartley observes, that it deserves particular attention, that the optic nerves of men, and such other animals as look the same way with both eyes, unite in the *fella turcica* in a ganglion, or little brain, as one may call it, peculiar to themselves; and that the associations between synchronous impressions on the two retinas must be made sooner and cemented stronger on this account; also that they ought to have a much greater power over one another's images, than in any other part of the body. And thus an impression made on the right eye alone, by a single object, may propagate itself into the left, and there raise up an image almost equal in vividness to itself; and consequently when we see with one eye only, we may, however, have pictures in both eyes.

A curious deception in vision, arising from the use of both eyes, was observed and accounted for by Dr Smith. It is a common observation, he says, that objects seen with both eyes appear more vivid and stronger than they do to a single eye; especially when both of them are equally good. A person not short-sighted may soon be convinced of this fact, by looking attentively at objects that are pretty remote, first with one eye, and then with both. This observation gave occasion to the construction of the binocular telescope, in the use of which the phenomenon is still more striking.

Besides this, our author observes, that there is another phenomenon observable with this instrument, which is very remarkable. In the foci of the two telescopes there are two equal rings, as usual, which terminate the pictures of the objects there formed, and consequently the visible area of the objects themselves. These equal rings, by reason of the equal eye-glasses, appear equal, and equally distant when seen separately by each eye; but when they are seen with both eyes, they appear much larger, and more distant also; and the

the objects seen through them do also appear much larger, though circumscribed by their united rings, in the same places as when they were seen separately.

He observes, that the phenomenon of the enlarged circle of the visible area in the binocular telescope, may be seen very plainly in looking at distant objects through a pair of spectacles, removed from the eyes about four or five inches, and held steady at that distance. The two innermost of the four apparent rings, which hold the glasses, will then appear united in one larger and more distant ring than the two outermost, which will hardly be visible unless the spectacles be farther removed.

A curious circumstance relating to the effect of one eye upon the other, was noticed by M. Æpinus, who observed, that, when he was looking through a hole made in a plate of metal, about the 10th part of a line in diameter, with his left eye, both the hole itself appeared larger, and also the field of view seen thro' it was more extended, whenever he shut his right eye; and both these effects were more remarkable when that eye was covered with his hand. He found considerable difficulty in measuring this augmentation of the apparent diameter of the hole, and of the field of view; but at length he found, that, when the hole was half an inch, and the tablet which he viewed through it was three feet from his eye, if the diameter of the field when both his eyes were open was 1, it became  $1\frac{1}{2}$  when the other eye was shut, and nearly 2 when his hand was laid upon it.

Upon examining this phenomenon, it presently appeared to depend upon the enlargement of the pupil of one eye when the other is closed, the physical or anatomical cause of which he did not pretend to assign; but he observes, that it is wisely appointed by divine Providence, in order that when one eye fails, the field of view in the other may be extended. That this effect should be more sensible when the eye is covered with the hand, is owing, he observes, to the eye-lids not being impervious to the light. But the enlargement of the pupil does not enlarge the field of view, except in looking through a hole, as in this particular case; and therefore persons who are blind of one eye can derive no advantage from this circumstance. Before we applaud the wisdom of Providence in any part of the constitution of nature, we should be very sure that we do not mistake concerning the effects of that constitution.

A great deal has been written by Gassendi, Le Clerc, Muschenbroek, and Du Tour, concerning the place to which we refer an object viewed by one or both eyes. But the subject is not of much consequence. Any person may presently satisfy himself with respect to every thing belonging to this circumstance, either by experiment, holding his finger before his eyes, and looking at it and an object beyond it; or by figures, in which lines representing the optic axes may be made to cross one another at different distances from the eye.

§ 4. *Of the Appearance of Objects seen through Media of different Forms.*

FOR the more easy apprehension of what relates to this subject, we shall premise the five following parti-

culars, which either have been already mentioned, or follow from what has been before laid down.

1. That as each point of an object, when viewed by the naked eye, appears in its proper place; and as that place is always to be found in the line in which the axis of a pencil of rays flowing from it enters the eye; we from hence acquire an habit of judging the point to be situated in that line: and, because the mind is unacquainted with what refractions the rays suffer before they enter the eye, therefore, in cases where they are diverted from their natural course, by passing through any medium, it judges the point to be in that line produced back in which the axis of a pencil of rays flowing from it is situated the instant they enter the eye, and not in that it was in before refraction. We shall therefore, in what follows, suppose the apparent place of an object, when seen thro' a refracting medium, to be somewhere in that line produced back in which the axis of a pencil of rays flowing from it proceeds after they have passed through the medium.

2. That we are able to judge, though imperfectly, of the distance of an object by the degree of divergence, wherein the rays flowing from the same point of the object enter the pupil of the eye, in cases where that divergence is considerable; but because in what follows it will be necessary to suppose an object, when seen through a medium whereby its apparent distance is altered, to appear in some determinate situation, in those cases where the divergence of the rays at their entrance into the eye is considerable, we will suppose the object to appear where those lines which they describe in entering, if produced back, would cross each other: though it must not be asserted, that this is the precise distance; because the brightness, distinctness, and apparent magnitude of the object, on which its apparent distance in some measure depends, will also suffer an alteration by the refraction of the rays in passing through that medium.

3. That we estimate the magnitude of an object by that of the optic angle.

4. That vision is the brighter, the greater the number of rays is which enter the pupil. And,

5. That, in some cases, the apparent brightness, distinctness, and magnitude of an object, are the only means whereby our judgment is determined in estimating the distance of it.

PROP. I. An object placed within a medium terminated by a plane surface on that side which is next the eye, if the medium be denser than that in which the eye is (as we shall always suppose it to be, unless where the contrary is expressed), appears nearer to the surface of the medium than it is.

Thus, if A be a point of an object placed within the medium BDCE (fig. 2.), and A b A c be two rays proceeding from thence, these rays passing out of a denser into a rarer medium, will be refracted from their respective perpendiculars b d, c e, and will enter the eye at H, suppose in the directions b f, c g, let then these lines be produced back till they meet in F; this will be the apparent place of the point A: and because the refracted rays b f, c g will diverge more than the incident ones A b, A c, it will be nearer to the points b and c, than the point A; and as the same is true of each point in the object, the whole.

whole will appear to an eye at *H*, nearer to the surface *BC* than it is.

From hence it is, that when one end of a straight stick is put under water, and the stick is held in an oblique position, it appears bent at the surface of the water; viz. because each point that is under water appears nearer the surface, and consequently higher than it is.

From hence likewise it is, that an object at the bottom of a vessel may be seen when the vessel is filled with water, though it be so placed with respect to the eye, that it cannot be seen when the vessel is empty. To explain this, let *ABCD* (fig. 3.) represent a vessel, and let *E* be an object lying at the bottom of it. This object, when the vessel is empty, will not be seen by an eye at *F*, because *HB*, the upper part of the vessel, will obstruct the ray *EH*; but when it is filled with water to the height *GH*, the ray *EK* being refracted at the surface of the water into the line *KF*, the eye at *F* shall see the object by means of that.

To like manner, an object situated in the horizon appears above its true place, upon account of the refraction of the rays which proceed from it in their passage through the atmosphere of the earth. For, first, if the object be situated beyond the limits of the atmosphere, its rays in entering it will be refracted towards the perpendicular; that is, towards a line drawn from the point where they enter, to the centre of the earth, which is the centre of the atmosphere: and as they pass on, they will be continually refracted the same way, because they are all along entering a denser part, the centre of whose convexity is still the same point; upon which account the line they describe will be a curve bending downwards: and therefore none of the rays that come from that object can enter an eye upon the surface of the earth, except what enter the atmosphere higher than they need to do if they could come in a right line from the object: consequently the object must appear above its proper place. Secondly, if the object be placed within the atmosphere, the case is still the same; for the rays which flow from it must continually enter a denser medium whose centre is below the eye; and therefore being refracted towards the centre, that is, downwards as before, those which enter the eye must necessarily proceed as from some point above the object; wherefore the object will appear above its proper place.

From hence it is, that the sun, moon, and stars, appear above the horizon, when they are just below it; and higher than they ought to do, when they are above it: Likewise distant hills, trees, &c. seem to be higher than they are.

Further, the lower these objects are in the horizon, the greater is the obliquity with which the rays which flow from them enter the atmosphere, or pass from the rarer into the denser parts of it; and therefore they appear to be the more elevated by refraction: upon which account the lower parts of them are apparently more elevated than the other. This makes their upper and under parts seem nearer than they are; as is evident from the sun and moon, which appear of an oval form when they are in the horizon, their horizontal diameters appearing of the same length they would do if the rays suffered no refraction, while their vertical

ones are shortened thereby.

PROP. II. An object seen through a medium terminated by plane and parallel surfaces, appears nearer, brighter, and larger, than with the naked eye.

For instance, let *AB* (fig. 4.) be the object, *CDEF* the medium, and *GH* the pupil of an eye, which is here drawn large to prevent confusion in the figure. And, 1st, let *RK*, *RL*, be two rays proceeding from the point *R*, and entering the denser medium at *K* and *L*; these rays will here by refraction be made to diverge less, and to proceed afterwards, suppoise in the lines *Ka*, *Lb*; at *a* and *b*, where they pass out of the denser medium, they will be as much refracted the contrary way, proceeding in the lines *ac*, *bd*, parallel to their first directions. Produce these lines back till they meet in *e*: this will be the apparent place of the point *R*; and it is evident from the figure, that it must be nearer the eye than that point; and because the same is true of all other pencils flowing from the object *AB*, the whole will be seen in the situation *fg*, nearer to the eye than the line *AB*. 2d, As the rays *RK*, *RL*, would not have entered the eye, but have passed by it in the directions *Kr*, *Lt*, had they not been refracted in passing through the medium, the object appears brighter. 3d, The rays *Ah*, *Bi*, will be refracted at *b* and *i* into the less converging lines *bk*, *il*, and at the other surface into *kM*, *lM*, parallel to *Ah* and *Bi* produced; so that the extremities of the object will appear in the lines *Mk*, *Ml* produced, viz. in *f* and *g*, and under as large an angle *fMg*, as the angle *AqB* under which an eye at *g* would have seen it had there been no medium interposed to refract the rays; and therefore it appears larger to the eye at *GH*, being seen through the interposed medium, than otherwise it would have done. But it is here to be observed, that the nearer the point *e* appears to the eye on account of the refraction of the rays *RK*, *RL*, the shorter is the image *fg*, because it is terminated by the lines *Mf* and *Mg*, upon which account the object is made to appear less; and therefore the apparent magnitude of an object is not much augmented by being seen through a medium of this form.

Farther, it is apparent from the figure, that the effect of a medium of this form depends wholly upon its thickness; for the distance between the lines *Kr* and *ec*, and consequently the distance between the points *e* and *R*, depends upon the length of the line *Ka*: Again, the distance between the lines *AM* and *fM*, depends on the length of the line *bk*; but both *Ku* and *kb* depend on the distance between the surfaces *CE* and *DF*, and therefore the effect of this medium depends upon its thickness.

PROP. III. An object seen through a convex lens, appears larger, brighter, and more distant, than with the naked eye.

To illustrate this, let *AB* (fig. 5.) be the object, *CD* the lens, and *EF* the eye. 1. From *A* and *B*, the extremities of the object, draw the lines *AYr*, *BXr*, crossing each other in the pupil of the eye; the angle *A-r-B* comprehended between these lines, is the angle under which the object would be seen with the naked eye. But by the interposition of a lens of this form, whose property it is to render converging rays more so, the



Of Refraction.

Plate  
CCXI.  
fig. 5.

the rays  $AY$  and  $BX$  will be made to cross each other before they reach the pupil. There the eye at  $E$  will not perceive the extremities of the object by means of these rays (for they will pass it without entering), but by some others which must fall without the points  $Y$  and  $X$ , or between them; but if they fall between them, they will be made to concur sooner than they themselves would have done; and therefore, if the extremities of the object could not be seen by them, it will much less be seen by these. It remains therefore, that the rays which will enter the eye from the points  $A$  and  $B$  after refraction, must fall upon the lens without the points  $Y$  and  $X$ ; let then the rays  $AO$  and  $BP$  be such. These after refraction entering the eye at  $r$ , the extremities of the object will be seen in the lines  $rQ$ ,  $rT$ , produced, and under the optic angle  $QrT$ , which is larger than  $ArB$ , and therefore the apparent magnitude of the object will be increased.

3. Let  $GHI$  be a pencil of rays flowing from the point  $G$ ; as it is the property of this lens to render diverging rays less diverging, parallel, or converging, it is evident, that some of those rays, which would proceed on to  $M$  and  $N$ , and miss the eye, were they to suffer no refraction in passing through the lens, will now enter it; by which means the object will appear brighter. 3. As to the apparent distance of the object, that will vary according to the situation of it with respect to the focus of parallel rays of the lens.

1. Then, let us suppose the object placed so much nearer the lens than its focus of parallel rays, that the refracted rays  $KE$  and  $LF$ , though rendered less diverging by passing through it, may yet have a considerable degree of divergency, so that we may be able to form a judgment of the distance of the object thereby. In this case, the object ought to appear where  $EK$ ,  $FL$ , produced back concur; which, because they diverge less than the rays  $GH$ ,  $GI$ , will be beyond  $G$ , that is, at a greater distance from the lens than the object is. But because both the brightness and magnitude of the object will at the same time be augmented, prejudice will not permit us to judge it quite so far off as the point where those lines meet, but somewhere between that point and its proper place.

2. Let the object be placed in the focus of parallel rays, then will the rays  $KE$  and  $LF$  become parallel; and though in this case the object would appear at an immense distance, if that distance were to be judged of by the direction of the rays  $KE$  and  $LF$ , yet upon account of the brightness and magnitude of it, we shall not think it much farther from us than if it were seen by the naked eye. 3. If the object be situated beyond the focus of parallel rays, as in  $BA$  (fig. 6.) the rays flowing from thence and falling upon the lens  $CD$ , will be collected into their respective foci at  $a$  and  $b$ , and the intermediate points  $m$ ,  $n$ , &c. and will there form an image of the object  $AB$ ; and after crossing each other in the several points of it, as expressed in the figure, will pass on diverging as from a real object. Now if an eye be situated at  $e$ , where  $Ac$ ,  $Bc$ , rays proceeding from the extreme points of the object, make not a much larger angle  $Acb$ , than they would do if there were no lens interposed, and the rays belonging to the same pencil do not converge so much as those the eye would receive if it were placed nearer to  $a$  or  $b$ , the object upon these accounts

appearing very little larger or brighter than with the naked eye, is seen nearly in its proper place; but if the eye recedes a little way towards  $ab$ , the object then appearing both brighter and larger, seems to approach the lens: which is an evident proof of what has been so often asserted, viz. that we judge of the distance of an object in some measure by its brightness and magnitude; for the rays converge the more the farther the eye recedes from the lens; and therefore if we judged of the distance of the object by the direction of the rays which flow from it, we ought in this case to conceive it at a greater distance, than when the rays were parallel, or diverged at their entrance into the eye.

That the object should seem to approach the lens in this case, was a difficulty that exceedingly puzzled the learned Barrow, and which he pronounces insuperable, and not to be accounted for by any theory we have of vision. Molineux also leaves it to the solution of others, as that which will be inexplicable, till a more intimate knowledge of the visive faculty, as he expresses it, be obtained by mortals.

They imagined, that seeing an object appears farther off, the lens the rays diverge which fall upon the eye: if they should proceed parallel to each other, it ought to appear exceeding remote; and if they should converge, it should then appear more distant still: the reason of this was, because they looked upon the apparent place of an object, as owing only to the direction of the rays whatever it was, and not at all to its apparent magnitude or splendor.

Perhaps it may proceed from our judging of the distance of an object in some measure by its magnitude, that that deception of sight commonly observed by travellers may arise; viz. that upon the first appearing of a building larger than usual, as a cathedral church, or the like, it generally seems nearer to them, than they afterwards find it to be.

PROP. IV. If an object be placed farther from a convex lens than its focus of parallel rays, and the eye be situated farther from it on the other side than the place where the rays of the several pencils are collected into their respective foci, the object appears inverted, and pendulous in the air, between the eye and the lens.

To explain this, let  $AB$  (fig. 6.) represent the object,  $CD$  the lens; and let the rays of the pencil  $ACD$  be collected in  $a$ , and those of  $BCD$  in  $b$ , forming there an inverted image of the object  $AB$ , and let the eye be placed in  $F$ : it is apparent from the figure, that some of the refracted rays which pass thro' each point of the image, will enter the eye as from a real object in that place; and therefore the object  $AB$  will appear there, as the proposition asserts. But we are so little accustomed to see objects in this manner, that it is very difficult to perceive the image with one eye; but if both eyes are situated in such a manner, that rays flowing from each point of the image may enter both, as at  $G$  and  $H$ , and we direct our optic axes to the image, it is easy to be perceived.

If the eye be situated in  $a$  or  $b$ , or very near them on either side, the object appears exceedingly confused, viz. if at  $d$ , the rays which proceed from the same point of the object converge so very much, and if at  $e$ , they diverge so much, that they can-

not be collected together upon the retina, but fall upon it as if they were the axes of so many distinct pencils coming through every point of the lens; wherefore little more than one single point of the object is seen at a time, and that appears all over the lens; from whence nothing but confusion arises.

If the lens be so large that both eyes may be applied to it, as in *b* and *k*, the object will appear double; for it is evident from the figure, that the rays which enter the eye at *b* from either extremity of the object *A* or *B*, do not proceed as from the same point with that from whence those which enter the other at *k* seem to flow; the mind therefore is here deceived, and looks upon the object as situated in two different places, and therefore judges it to be double.

PROP. V. An object seen through a concave lens appears nearer, smaller, and less bright, than with the naked eye.

Plate  
CCXI.

Thus, let *AB* (fig. 7.) be the object, *CD* the pupil of an eye, and *EF* the lens. Now, as it is the property of a lens of this form, to render diverging rays more so, and converging ones less so, the diverging rays *GH*, *GI*, proceeding from the point *G*, will be made to diverge more, and so to enter the eye as from some nearer point *g*; and the rays *AH*, *BI*, which converge, will be made to converge less, and to enter the eye as from the points *a* and *b*; wherefore the object will appear in the situation *agb*, less and nearer than without the lens. Farther, as the rays which proceed from *G* are rendered more diverging, some of them will be made to pass by the pupil of the eye, which otherwise would have entered it, and therefore each point of the object will appear less bright.

PROP. VI. An object seen thro' a polygonous glass, that is, such as is terminated by several plain surfaces, is multiplied thereby.

For instance, let *A* (fig. 8.) be an object, and *BC* a polygonous glass terminated by the plain surfaces *BD*, *DE*, &c. and let the situation of the eye *F* be such, that the rays *AB* being refracted in passing thro' the glass, may enter it in the direction *BF*, and the rays *AC* in the direction *CF*. Then will the eye, by means of the former, see the object in *G*, and by the latter in *H*; and by means of the rays *AI*, the object will appear also in its proper situation *A*.

### SECT. II. Of the Reflection of Light.

WHEN a ray of light falls upon any body, however transparent, the whole of it never passes through the body, but some part is always driven back or reflected from it; and it is by this reflected light that all bodies which have no light of their own become visible to us. Of that part of the ray which enters, another part is also reflected from the second surface, or that which is farthest from the luminous body. When this part arrives again at the first surface, part of it is reflected back from that surface; and thus it continues to be reflected between the two surfaces, and to pass backwards and forwards within the substance of the medium, till some part is totally extinguished and lost. Besides this inconsiderable quantity, however, which is lost in this manner, the second surface often reflects much more than the first; insomuch that, in certain positions, scarce any rays will pass through both sides of

the medium. A very considerable quantity is also unaccountably lost or extinguished at each reflecting surface; insomuch that no body, however transparent, can transmit all the rays which fall upon it; neither, tho' it be ever so well fitted for reflection, will it reflect them all.

#### § 1. Of the Cause of Reflection.

THE reflection of light is by no means so easily accounted for as the refraction of the same fluid. This property, as we have seen in the last section, may be accounted for in a satisfactory manner by the supposition of an attractive power diffused throughout the medium, and extending a very little way beyond it; but with regard to the reflection of light, there seems to be no satisfactory hypothesis hitherto invented. Of the principal opinions on this subject Mr Rowning hath given us the following account.

I. It was the opinion of philosophers before Sir Isaac Newton discovered the contrary, that light is reflected by impinging upon the solid parts of bodies. But that it is not so, is clear for the following reasons.

And first, it is not reflected at the first surface of a <sup>127</sup>Light is not reflected by impinging against it.

For it is evident, that in order to the due and regular reflection of light, that is, that the reflected rays should not be dispersed and scattered one from another, there ought to be no rasures or unevenness in the reflecting surface large enough to bear a sensible proportion to the magnitude of a ray of light; because if the surface abounds with such, the reflected rays will rather be scattered like a parcel of pebbles thrown upon a rough pavement, than reflected with that regularity with which light is observed to be from a well-polished surface. Now those surfaces, which to our senses appear perfectly smooth and well polished, are far from being so; for to polish, is no other than to grind off the larger eminences and protuberances of the metal with the rough and sharp particles of sand, emery, or putty, which must of necessity leave behind them an infinity of rasures and scratches, which, tho' inconsiderable with regard to the former roughnesses, and too minute to be discerned by us, must nevertheless bear a large proportion to, if not vastly exceed, the magnitude of the particles of light.

Secondly, it is not reflected at the second surface, <sup>128</sup>Nor at the second, by impinging against any solid particles.

That it is not reflected by impinging upon the solid particles which constitute this second surface, is sufficiently clear from the foregoing argument; the second surfaces of bodies being as incapable of a perfect polish as the first; and it is farther confirmed from hence, viz. that the quantity of light reflected differs according to the different density of the medium behind the body: And that it is not reflected by impinging upon the particles which constitute the surface of the medium behind it, is evident, because the strongest reflection of all at the second surface of a body, is when there is a vacuum behind it. This therefore wants no farther proof.

II. It has been thought by some, that it is re-<sup>129</sup>Supposition of a repulsive force. flected at the first surface of a body, by a repulsive force equally diffused over it; and at the second, by an attractive force.

Fig. 1.

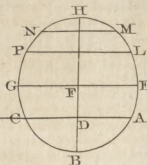


Fig. 4.

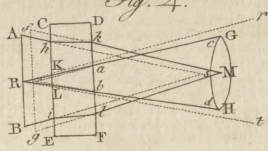


Fig. 7.

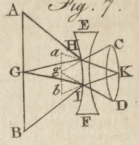


Fig. 2.

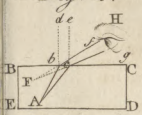


Fig. 3.

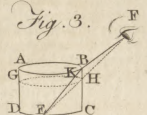


Fig. 5.

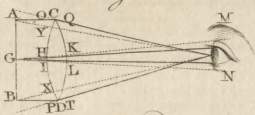


Fig. 8.

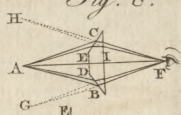


Fig. 6.

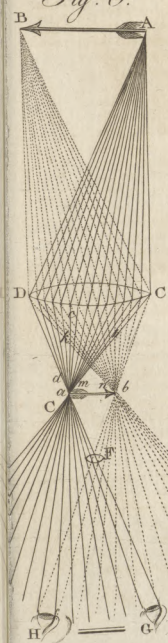


Fig. 13.

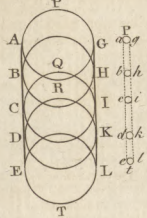


Fig. 9.

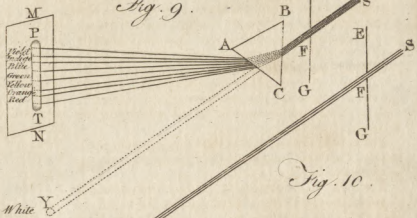


Fig. 10.

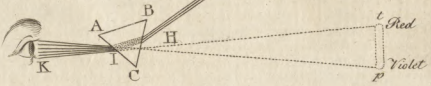


Fig. 11.

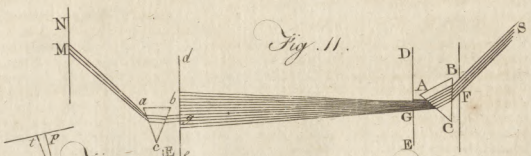


Fig. 12.

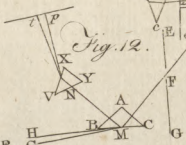


Fig. 15.

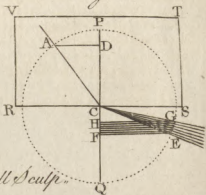
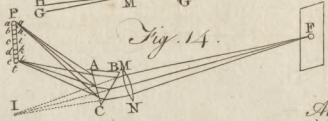


Fig. 14.



Abell Sculp.

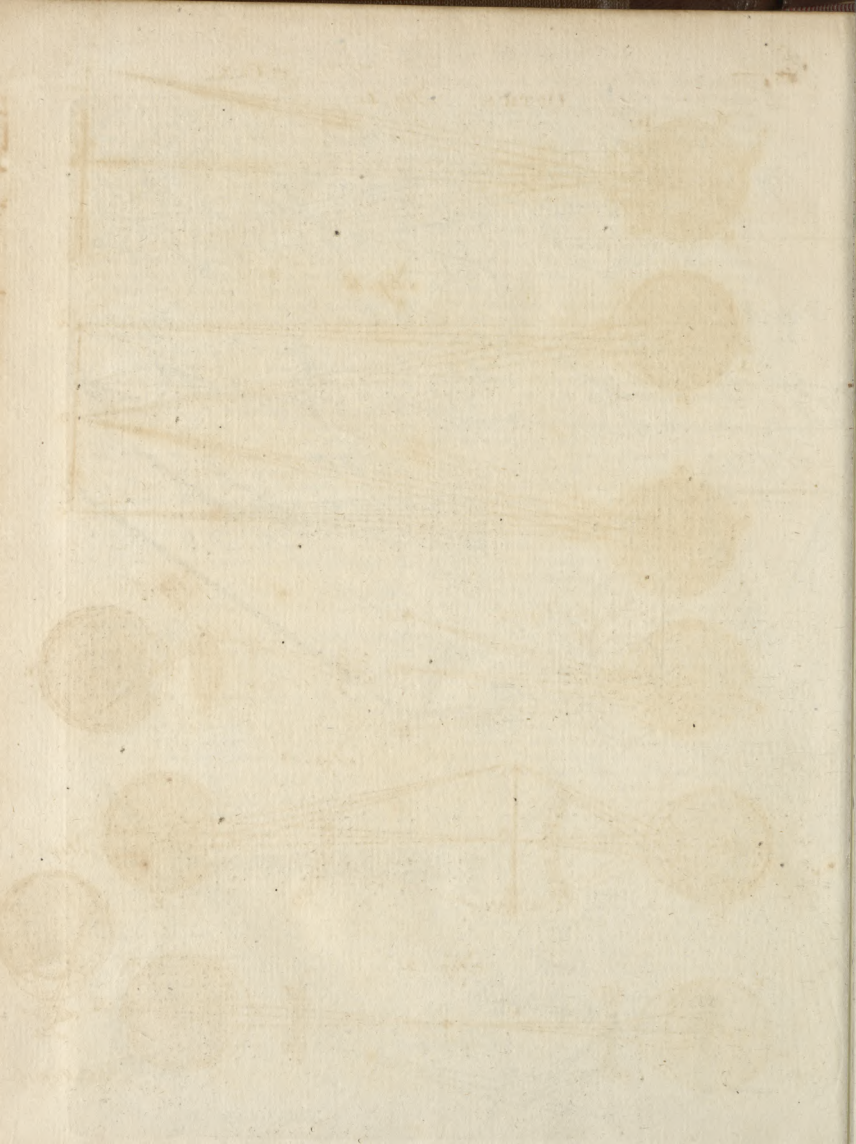


Fig. 1.



Fig. 2.

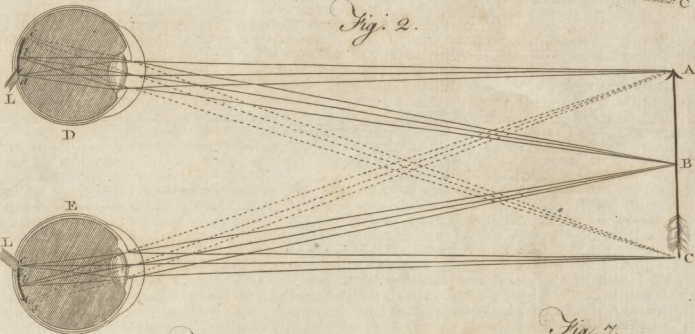


Fig. 4.

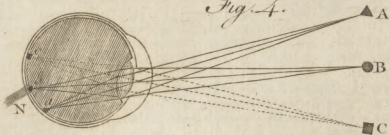


Fig. 7.

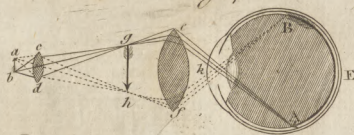


Fig. 3.

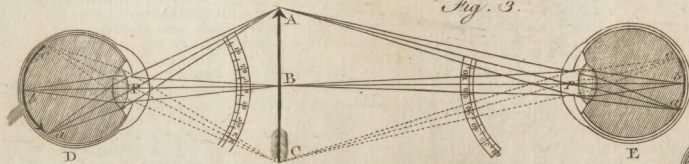
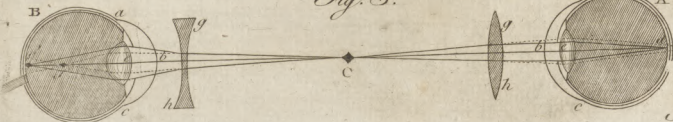
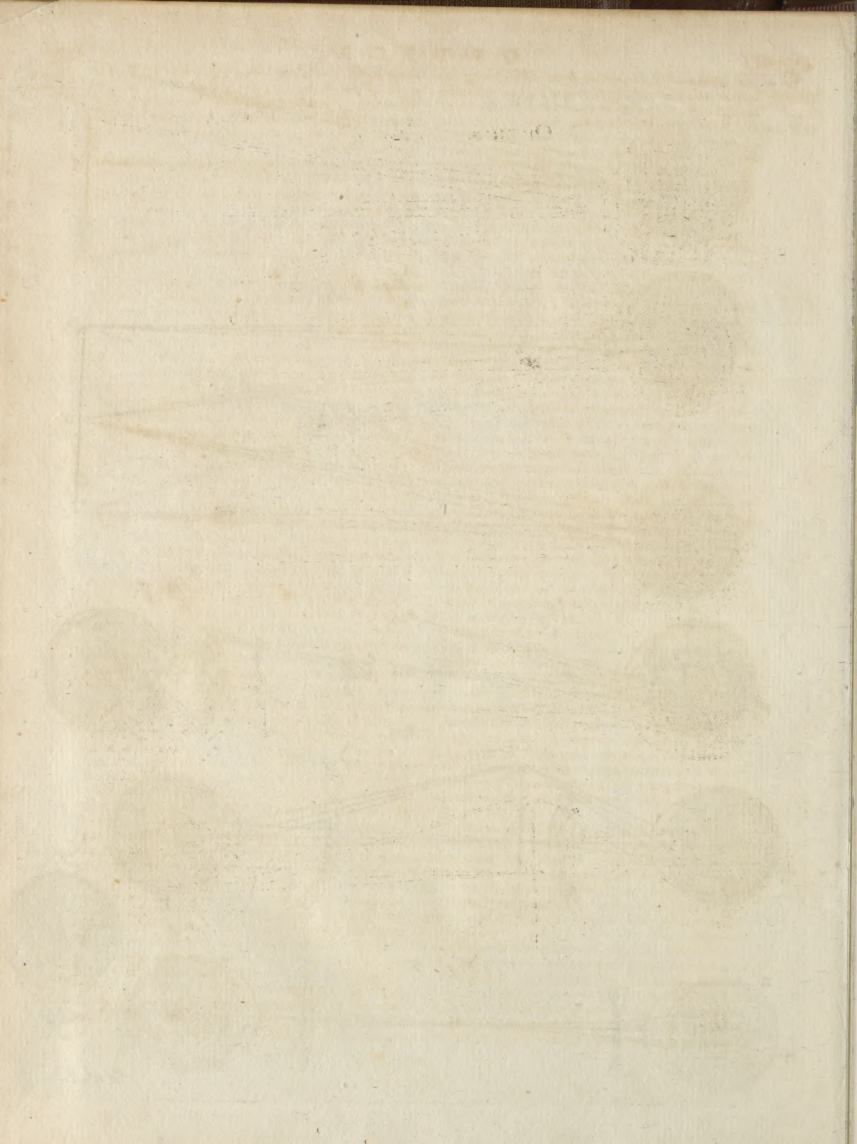


Fig. 6.



Fig. 5.





Of  
Reflection.  
130  
Objected to

1. If there be a repulsive force diffused over the surface of bodies that repels rays of light at all times, then, since by increasing the obliquity of a ray we diminish its perpendicular force (which is that only, whereby it must make its way through this repulsive force), however weakly that force may be supposed to act, rays of light may be made to fall with so great a degree of obliquity on the reflecting surface, that there shall be a total reflection of them there, and not one particle of light be able to make its way through: which is contrary to observation; the reflection of light at the first surface of a transparent body being never total in any obliquity whatever. The hypothesis therefore in this particular must be false.

131  
Attractive  
force sup-  
posed.

2. As to the reflection at the second surface by the attractive force of the body; this may be considered in two respects: first, when the reflection is total; secondly, when it is partial.

And first, in cases where the reflection is total, the cause of it is undoubtedly that same attractive force by which light would be refracted in passing out of the same body. This is manifest from that analogy which is observable between the reflection of light at this second surface, and its refraction there. For otherwise, what can be the reason that the total reflection should begin just when the obliquity of the incident ray, at its arrival at the second surface, is such, that the refracted angle ought to be a right one; or when the ray, were it not to return in reflection, ought to pass on parallel to the surface, without going from it? For in this case it is evident, that it ought to be returned by this very power, and in such manner that the angle of reflection shall be equal to the angle of incidence: just as a stone thrown obliquely from the earth, after it is so far turned out of its course by the attraction of the earth, as to begin to move horizontally, or parallel to the surface of the earth, is then by the same power made to return in a curve similar to that which is described in its departure from the earth, and so falls with the same degree of obliquity that it was thrown with.

But secondly, as to the reflection at the second surface, when it is partial; an attractive force uniformly spread over it, as the maintainers of this hypothesis conceive it to be, can never be the cause thereof. Because it is inconceivable, that the same force, acting in the same circumstances in every respect, can sometimes reflect the violet coloured rays and transmit the red, and at other times reflect the red and transmit the violet.

This argument concludes equally against a repulsive force uniformly diffused over the first surface of a body, and reflecting light there; because some bodies reflect the violet and transmit the red, others reflect the red and transmit the violet, at their first surface; which cannot possibly be upon this supposition, the rays of whichever of these colours we suppose to be the strongest.

132  
Another  
ypothesis.

III. Some, being apprehensive of the insufficiency of a repulsive and attractive force diffused over the surfaces of bodies and acting uniformly, have supposed, that, by the action of light upon the surface of bodies, the matter of these forces is put into an undulatory motion; and that where the surface of it is subsiding light is transmitted, and in those places where it is

rising light is reflected. But this seems not to advance us one jot farther; for in those cases, suppose where red is reflected and violet transmitted, how comes it to pass that the red impinges only on those parts when the waves are rising, and the violet when they are subsiding?

IV. The next hypothesis that we shall take notice of, is that remarkable one of Sir Isaac Newton's fits of easy reflection and transmission, which we shall now explain and examine.

133  
Sir Isaac  
Newton's  
hypothesis.

That author, as far as we can apprehend his meaning in this particular, is of opinion, that light, in its passage from the luminous body, is disposed to be alternately reflected by and transmitted through any refracting surface it may meet with; that these dispositions (which he calls *fits of easy reflection and easy transmission*) return successively at equal intervals: and that they are communicated to it at its first emission out of the luminous body it proceeds from, probably by some very subtle and elastic substance diffused through the universe, and that in the following manner. As bodies falling into water, or passing through the air, cause undulations in each, so the rays of light may excite vibrations in this elastic substance. The quickness of which vibrations depending on the elasticity of the medium (as the quickness of the vibrations in the air, which propagate sound, depend solely on the elasticity of the air, and not upon the quickness of those in the sounding body) the motion of the particles of it may be quicker than that of the rays: and therefore, when a ray at the instant it impinges upon any surface, is in that part of a vibration of this elastic substance which conspires with its motion, it may be easily transmitted; and when it is in that part of a vibration which is contrary to its motion, it may be reflected. He farther supposes, that when light falls upon the first surface of a body, none is reflected there; but all that happens to it there is, that every ray that is not in a fit of easy transmission is there put into one, so that when they come at the other side (for this elastic substance, easily pervading the pores of bodies, is capable of the same vibrations within the body as without it) the rays of one colour shall be in a fit of easy transmission, and those of another in a fit of easy reflection, according to the thickness of the body, the intervals of the fits being different in rays of a different kind. This very well accounts for the different colours of the bubble and thin plate of air and water, as is obvious enough; and likewise for the reflection of light at the second surface of a thicker body; for the light reflected from thence is also observed to be coloured, and to form rings according to the different thickness of the body, when not intermixed and confounded with other light, as will appear from the following experiment. If a piece of glass be ground concave on one side and convex on the other, both its concavity and convexity having one common centre; and if a ray of light be made to pass through a small hole in a piece of paper held in that common centre, and be permitted to fall on the glass; besides those rays which are regularly reflected back to the hole again, there will be others reflected to the paper, and form coloured rings surrounding the hole, not unlike those occasioned by the reflection of light from thin plates.

The same will happen if the rays be reflected from a metalline speculum, but the light will not be coloured; which shews, that the colours arise from that light which is reflected from the back side, and that in the following manner: Besides that light which is regularly reflected from the farther surface of the glass, there is some reflected irregularly, which, passing from the back surface under the different obliquities, does as it were pass through glasses of different thicknesses, and therefore is in part reflected back again when it comes to the first surface, and is in part transmitted through it, the transmitted light, when received upon the white paper, exhibiting the rings of colours above-mentioned.

As to the light which is supposed to be reflected at the first surface, his opinion seems to be, That it is not there reflected, but that it really enters the surface, and is reflected from the back-side of the first series of particles that lie therein: so that, according as these particles are larger or smaller, the rays of light which at their entrance into them (for they are transparent, whether the body they compose be so or not) are thereby put into fits of easy transmission, at their emergence at the other side are some in a fit of easy transmission, others in a fit of easy reflection, according as the interval of their fits are large or small. So that the particles of a body may be of such a size that they shall reflect the red and transmit the violet, or that they may reflect the violet and transmit the red; or, in general, that the strongest and most forcible rays may be transmitted while the weaker are reflected; or the weaker may be transmitted while the stronger are reflected.

### §. 2. Of the *Laws of Reflection.*

THE fundamental law of the reflection of light is, that in all cases the angle of reflection is equal to the angle of incidence. This is found by experiment to be the case, and besides may be demonstrated mathematically from the laws of percussion in bodies perfectly elastic. The axiom therefore holds good in every case of reflection, whether it be from plain surfaces or spherical ones, and that whether they are convex or concave; and hence the seven following propositions relating to the reflection of light from plain and spherical surfaces may be deduced.

I. Rays of light reflected from a plain surface have the same degree of inclination to one another that their respective incident ones have.—For the angle of reflection of each ray being equal to that of its respective incident one, it is evident, that each reflected ray will have the same degree of inclination to that portion of the surface from whence it is reflected that its incident one has: but it is here supposed, that all those portions of surface from whence the rays are reflected, are situated in the same plain; consequently the reflected rays will have the same degree of inclination to each other that their incident ones have, from whatever part of the surface they are reflected.

II. Parallel rays reflected from a concave surface are rendered converging.—To illustrate this, let AF, CD, EB, (fig. 1.) represent three parallel rays falling upon the concave surface FB, whose centre is C. To the points F and B draw the lines CF, CB; these being drawn from the centre, will be perpendi-

cular to the surface at those points. The incident ray CD also passing through the centre, will be perpendicular to the surface, and therefore will return after reflection in the same line; but the oblique rays AF and EB will be reflected into the lines FM and BM, situated on the contrary side of their respective perpendiculars CF and CB. They will therefore proceed converging after reflection towards some point, as M, in the line CD.

III. Converging rays falling on the like surface, are made to converge more.—For, every thing remaining as above, let GF, HB, be the incident rays. Now, because these rays have larger angles of incidence than the parallel ones AF and EB in the foregoing case, their angles of reflection will also be larger than those of the others; they will therefore converge after reflection, suppose in the lines FN and BN, having their point of concurrence N farther from the point C than M, that to which the parallel rays AF and EB converged to in the foregoing case; and their precise degree of convergency will be greater than that wherein they converged before reflection.

IV. Diverging rays falling upon the like surface, are, after reflection, parallel, diverging, or converging. If they diverge from the focus of parallel rays, they then become parallel; if from a point nearer to the surface than that, they will diverge, but in a less degree than before reflection; if from a point between that and the centre, they will converge after reflection, and that to some point on the contrary side of the centre, but situated farther from it than the point from which they diverged. If the incident rays diverge from a point beyond the centre, the reflected ones will converge to one on the other side of it, but nearer to it than the point they diverged from; and if they diverge from the centre, they will be reflected thither again.

1. Let them diverge in the lines MF, MB, proceeding from M, the focus of parallel rays; then, as the parallel rays AF and EB were reflected into the lines FM and BM, (by Prop. II.) these rays will now on the contrary be reflected into them.

2. Let them diverge from N, a point nearer to the surface than the focus of parallel rays, they will then be reflected into the diverging lines FG and BH, which the incident rays GF and HB described that were shewn to be reflected into them in the foregoing proposition; but the degree wherein they diverge will be less than that wherein they diverged before reflection.

3. Let them proceed diverging from X, a point between the focus of parallel rays and the centre; they then make less angles of incidence than the rays MF and MB, which became parallel by reflection: they will consequently have less angles of reflection, and proceed therefore converging towards some point, as Y; which point will always fall on the contrary side of the centre, because a reflected ray always falls on the contrary side of the perpendicular with respect to that on which its incident one falls; and of consequence it will be farther distant from the centre than X.

4. If the incident ones diverge from Y, they will, after reflection, converge to X; those which were the incident rays in the former case being the reflected

ones



ones in this. And, lastly,

5. If the incident rays proceed from the centre, they fall in with their respective perpendiculars; and for that reason are reflected thither again.

V. Parallel rays reflected from a convex surface, are rendered diverging.—For, let AB, GD, EF, (fig. 2.) be three parallel rays falling upon the convex surface BF, whose centre of convexity is C, and let one of them, viz. GD, be perpendicular to the surface. Through B, D, and F, the points of reflection, draw the lines CV, CG, and CT; which, because they pass through the centre, will be perpendicular to the surface at these points. The incident ray GD being perpendicular to the surface, will return after reflection in the same line, but the oblique ones AB and EF in the lines BK and FL situated on the contrary side of their respective perpendiculars BV and FT. They will therefore diverge, after reflection, as from some point M in the line GD produced; and this point will be in the middle between D and C.

VI. Diverging rays reflected from the like surface, are rendered more diverging.—For, every thing remaining as above, let GB, GF, be the incident rays. These having larger angles of incidence than the parallel ones AB and EF in the preceding case, their angles of reflection will also be larger than theirs: they will therefore diverge after reflection, suppose in the lines BP and FQ, as from some point N, farther from C than the point M; and the degree wherein they will diverge will be greater than that wherein they diverged before reflection.

VII. Converging rays reflected from the like surface, are parallel, converging, or diverging. If they tend towards the focus of parallel rays, they then become parallel; if to a point nearer the surface than that, they converge, but in a less degree than before reflection; if to a point between that and the centre, they will diverge after reflection, as from some point on the contrary side of the centre, but situated farther from it than the point they converged to: if the incident rays converge to a point beyond the centre, the reflected ones will diverge as from one on the contrary side of it, but nearer to it than the point to which the incident ones converged; and if the incident rays converge towards the centre, the reflected ones will proceed as from thence.

1. Let them converge in the lines KB and LF, tending towards M, the focus of parallel rays; then, as the parallel rays AB EF were reflected into the lines BK and FL (by Prop. V.), those rays will now on the contrary be reflected into them.

2. Let them converge in the lines PB, QF, tending towards N a point nearer the surface than the focus of parallel rays, they will then be reflected into the converging lines BG and FG, in which the rays GB GF proceeded that were shewn to be reflected into them by the last proposition: but the degree wherein they will converge will be less than that wherein they converged before reflection.

3. Let them converge in the lines RB and SF proceeding towards X, a point between the focus of parallel rays and the centre; their angles of incidence will then be less than those of the rays KB and LF, which became parallel after reflection: their angles of

reflection will therefore be less; on which account they must necessarily diverge, suppose in the lines BH and FI, from some point, as Y; which point, (by Prop. IV.) will fall on the contrary side of the centre with respect to X, and will be farther from it than that.

4. If the incident rays tend towards Y, the reflected ones will diverge as from X; those which were the incident ones in one case, being the reflected ones in the other.

5. Lastly, if the incident rays converge towards the centre, they fall in with their respective perpendiculars; on which account they proceed after reflection as from the centre.

We have already observed, that in some cases there is a very great reflection from the second surface of a transparent body. The degree of inclination necessary to cause a total reflection of a ray at the second surface of a medium, is that which requires that the refracted angle (supposing the ray to pass out there) should be equal to or greater than a right one; and consequently it depends on the refractive power of the medium through which the ray passes, and is therefore different in different media. When a ray passes through glass surrounded with air, and is inclined to its second surface under an angle of 42 degrees or more, it will be wholly reflected there. For, as 11 is to 17, (the ratio of refraction out of glass into air), so is the sine of an angle of 42 degrees to a fourth number, that will exceed the sine of a right angle. From hence it follows, that when a ray of light arrives at the second surface of a transparent substance with as great, or a greater degree of obliquity, than that which is necessary to make a total reflection, it will there be all returned back to the first; and if it proceeds towards that with as great an obliquity as it did towards the other, (which it will do if the surfaces of the medium be parallel to each other), it will there be all reflected again, &c. and will therefore never get out, but pass from side to side, till it be wholly suffocated and lost within the body.—From hence may arise an obvious inquiry, how it comes to pass, that light falling very obliquely upon a glass window from without, should be transmitted into the room? In answer to this it must be considered, that however obliquely a ray falls upon the surface of any medium whose sides are parallel, (as those of the glass in a window are), it will suffer such a degree of refraction in entering there, that it shall fall upon the second with a less obliquity than that which is necessary to cause a total reflection. For instance, let the medium be glass, as supposed in the present case; then, as 17 is to 11, (the ratio of refraction out of air into glass), so is the sine of the largest angle of incidence with which a ray can fall upon any surface to the sine of a less angle than that of total reflection. And therefore, if the sides of the glass be parallel, the obliquity with which a ray falls upon the first surface, cannot be so great, but that it shall pass the second without suffering a total reflection there.

When light passes out of a denser into a rarer medium, the nearer the second medium approaches the first in density (or more properly in its refractive power), the less of it will be refracted in passing from one to the other; and when their refracting powers are equal,

equal, all of it will pass into the second medium.

The above propositions may be all mathematically demonstrated in the following manner.

PROP. I. Of the reflection of rays from a plain surface.

“When rays fall upon a plain surface, if they diverge, the focus of the reflected rays will be at the same distance behind the surface, that the radiant point is before it: if they converge, it will be at the same distance before the surface, that the imaginary focus of the incident rays is behind it.”

This proposition admits of two cases.

CASE 1. Of diverging rays.

DEM. Let AB, AC, (fig. 3.) be two diverging rays incident on the plain surface DE, the one perpendicularly, the other obliquely: the perpendicular one AB will be reflected to A, proceeding as from some point in the line AB produced; the oblique one AC will be reflected into some line as CF, such that the point G, where the line FG produced intersects the line AB produced also, shall be at an equal distance from the surface DE with the radiant A. For the perpendicular CH being drawn, ACH and HCF will be the angles of incidence and reflection; which being equal, their complements ACB and FCE are so too: but the angle BCG is equal to FCE, as being vertical to it: therefore in the triangles ABC and GBC the angles at C are equal, the side BC is common, and the angles at B are also equal to each other, as being right ones; therefore the lines AB and BG, which respect the equal angles at C, are also equal; and consequently the point G, the focus of the incident rays AB, AC, is at the same distance behind the surface, that the point A is before it. *Q. E. D.*

CASE 2. Of converging rays.

This is the converse of the former case. For supposing FC and AB to be two converging incident rays, CA and BA will be the reflected ones (the angles of incidence in the former case being now the angles of reflection, and *vice versa*), having the point A from their focus; but this, from what was demonstrated above, is at an equal distance from the reflecting surface with the point G, which in this case is the imaginary focus of the incident rays, FC, and AB.

Obs. It is not here, as in the refraction of rays in passing through a plain surface, where some of the refracted rays proceed as from one point, and some as from another: but they all proceed after reflection as from one and the same point, however obliquely they may fall upon the surface; for what is here demonstrated of the ray AC holds equally of any other, as AI, AK, &c.

The case of parallel rays incident on a plain surface, is included in this proposition: for in that case we are to suppose the radiant to be at an infinite distance from the surface, and then by the proposition the focus of the reflected rays will be too; that is, the rays will be parallel after reflection, as they were before.

PROP. II. Of the reflection of parallel rays from a spherical surface.

“When parallel rays are incident upon a spherical surface, the focus of the reflected rays will be the middle point between the centre of convexity and the surface.”

This proposition admits of two cases.

CASE 1. Of parallel rays falling upon a convex surface.

DEM. Let AB, DH, (fig. 4.) represent two parallel rays incident on the convex surface BH, the one perpendicularly, the other obliquely; and let C be the centre of convexity; suppose HE to be the reflected ray of the oblique incident one DH proceeding as from F, a point in the line AB produced. Through the point H draw the line CI, which will be perpendicular to the surface at that point; and the angles DH and IHF, being the angles of incidence and reflection, will be equal. To the former of these, the angle HCF is equal, the lines AC and DH being parallel, and to the latter the angle CAF as being vertical; wherefore the triangle CFH is isosceles, and consequently the sides CF and FH are equal: but supposing BH to vanish, FH is equal to FB; and therefore upon this supposition FC and FB are equal, that is, the focus of the reflected rays is the middle point between the centre of convexity and the surface. *Q. E. D.*

CASE 2. Of parallel rays falling upon a concave surface.

DEM. Let AB, DH (fig. 5.) be two parallel rays incident, the one perpendicularly, the other obliquely, on the concave surface BH, whose centre of concavity is C. Let BF and HF be the reflected rays meeting each other in F; this will be the middle point between B and C. For drawing through C the perpendicular CH, the angles DHC and FHC, being the angles of incidence and reflection, will be equal, to the former of which the angle HCF is equal, as alternate; and therefore the triangle CFH is isosceles. Wherefore CF and FH are equal: but if we suppose BH to vanish, FB and FH are also equal, and therefore CF is equal to FB; that is, the focal distance of the reflected rays is the middle point between the centre and the surface. *Q. E. D.*

Obs. It is here observable, that the farther the line DH, either in fig. 4. or 5. is taken from AB, the nearer the point F falls to the surface. For the farther the point H recedes from B, the larger the triangle CFH will become; and consequently, since it is always an isosceles one, and the base CH, being the radius, is every where of the same length, the equal legs CF and FH will lengthen; but CF cannot grow longer unless the point F approach towards the surface. And the farther H is removed from B, the faster F approaches to it.

This is the reason, that whenever parallel rays are considered as reflected from a spherical surface, the distance of the oblique one from the perpendicular one is taken so small with respect to the focal distance of that surface, that without any physical error it may be supposed to vanish.

From hence it follows, that if a number of parallel rays, as AB, CD, EG, &c. fall upon a convex surface, (as fig. 6.) and if BA, DK, the reflected rays of the incident ones AB, CD, proceed as from the point F, those of the incident ones CD, EG, viz. DK, EG, will proceed as from N, those of the incident ones GL, HI, as from O, &c. because the farther the incident ones CD, EG, &c. are from AB, the nearer to the surface are the points F, N, O, in the line BF, from which they proceed after reflection; so that properly the foci of the reflected rays BA, DK, GL, &c. are

not

not in the line AB produced, but in a curve line passing thro' the points F, N, O, &c.

The same is applicable to the case of parallel rays reflected from a concave surface, as expressed by the prickled lines on the other half of the figure, where PQ, RS, TV, are the incident rays; QF, Sf, Vf, the reflected ones, intersecting each other in the points X, Y, and F; so that the foci of those rays are not in the line FB, but in a curve passing through those points.

Had the surface BH in fig. 4. or 5. been formed by the revolution of a parabola about its axis having its focus in the point F, all the rays reflected from the convex surface would have proceeded as from the point F, and those reflected from the concave would have fallen upon it, however distant their incident ones AB, DH, might have been from each other. For in the parabola, all lines drawn parallel to the axis make angles with the tangents to the points where they cut the parabola (that is, with the surface of the parabola) equal to those which are made with the same tangents by lines drawn from thence to the focus; therefore, if the incident rays describe those parallel lines, the reflected ones will necessarily describe these other, and so will all proceed as from, or meet in, the same point.

PROP. III. Of the reflection of diverging and converging rays from a spherical surface.

“When rays fall upon any spherical surface, if they diverge, the distance of the focus of the reflected rays from the surface is to the distance of the radiant point from the same (or, if they converge, to that of the imaginary focus of the incident rays), as the distance of the focus of the reflected rays from the centre is to the distance of the radiant point (or imaginary focus of the incident rays) from the same.”

This proposition admits of ten cases.

CASE 1. Of diverging rays falling upon a convex surface.

DEM. Let RB, RD (fig. 7.) represent two diverging rays flowing from the point R as from a radiant, and falling the one perpendicularly, the other obliquely, on the convex surface BD, whose centre is C. Let DE be the reflected ray of the incident one RD, produce ED to F, and through R draw the line RH parallel to FE till it meets CD produced in H. Then will the angle RHD be equal to EDH the angle of reflection, as being alternate to it, and therefore equal also to RDH which is the angle of incidence; wherefore the triangle DRH is isosceles, and consequently DR is equal to RH. Now the lines FD and RH being parallel, the triangles FDC and RHC are similar, (or to express it in Euclid's way, the sides of the triangle RHC are cut proportionably, 2 Elem. 6.): and therefore FD is to RH, or its equal RD, as CF to CR; but BD vanishing, FD and RD differ not from FB and RB: wherefore FB is to RB also, as CF to CR; that is, the distance of the focus from the surface is to the distance of the radiant point from the same, as the distance of the focus from the centre is to the distance of the radiant from thence. Q. E. D.

CASE 2. Of converging rays falling upon a concave surface.

DEM. Let KD and CB be the converging inci-

dent rays having their imaginary focus in the point R, which was the radiant in the foregoing case. Then as RD was in that case reflected into DE, KD will in this be reflected into DF; for, since the angles of incidence in both cases are equal, as they are by being vertical, the angles of reflection will be too; so that F will be the focus of the reflected rays: but it was there demonstrated, that FB is to RB as CF to CR; that is, the distance of the focus from the surface is to the distance (in this Case) of the imaginary focus of the incident rays, as the distance of the focus from the centre is the distance of the imaginary focus of the incident rays from the same. Q. E. D.

CASE 3. Of converging rays falling upon a convex surface, and tending to a point between the focus of parallel rays and the centre.

DEM. Let BD (fig. 8.) represent a convex surface whose centre is C, and whose focus of parallel rays is P; and let AB, KD, be two converging rays incident upon it, and having their imaginary focus at R, a point between P and C. Now because KD tends to a point between the focus of parallel rays and the centre, the reflected ray DE will diverge from some point on the other side the centre, suppose F; as explained above (p. 5547.) under prop. 7. Through D draw the perpendicular CD, and produce it to H; then will KDH and HDE be the angles of incidence and reflection, which being equal, their vertical ones RDC and CDF will be too, and therefore the vertex of the triangle RDF is bisected by the line DC; wherefore (3 El. 6.) FD and DR or BD vanishing, FB and BR are to each other as FC to CR; that is, the distance of the focus of the reflected rays is to that of the imaginary focus of the incident ones, as the distance of the former from the centre is to the distance of the latter from the same. Q. E. D.

CASE 4. Of diverging rays falling upon a concave surface, and proceeding from a point between the focus of parallel rays and the centre.

DEM. Let RB, RD, be the diverging rays incident upon the concave surface BD, having their radiant point in the point R, the imaginary focus of the incident rays in the foregoing case. Then as KD was in that case reflected into DE, RD will now be reflected into DF. But it was there demonstrated, that FB and RB are to each other, as CF to CR; that is, the distance of the focus is to that of the radiant, as the distance of the former from the centre is to the distance of the latter from the same. Q. E. D.

The angles of incidence and reflection being equal, it is evident, that if, in any case, the reflected ray be made the incident one, the incident will become the reflected one: and therefore the four following cases may be considered respectively as the converse of the four foregoing; for in each of them the incident rays are supposed to coincide with the reflected ones in the other. Or they may be demonstrated independently of them as follows.

CASE 5. Of converging rays falling upon a convex surface, and tending to a point nearer the surface than the focus of parallel rays.

DEM. Let ED, RB (fig. 7.) be the converging rays incident upon the convex surface BD whose centre

Of  
Reflection.

tre is C, and focus of parallel rays is at P; and let the imaginary focus of the incident rays be at F, a point between P and B; and let DR be the reflected ray. From C and R draw the lines CH, RH, the one passing through D, the other parallel to FE. Then will the angle RHD be equal to HDE the angle of incidence, as alternate to it; and therefore equal to HDR, the angle of reflection: wherefore the triangle HDR is isosceles, and consequently DR is equal to RH. Now the lines FD and RH being parallel, the triangles FDC and RHC are similar; and therefore RH, or RD, is to FD as CR to CF: but BD vanishing, RD and FD coincide with RB and FB, wherefore RB is to FB as CR to CF; that is, the distance of the focus from the surface is to the distance of the imaginary focus of the incident rays, as the distance of the focus from the centre is to the distance of the imaginary focus of the incident rays from the same. *Q. E. D.*

CASE 6. Of diverging rays falling upon a concave surface, and proceeding from a point between the focus of parallel rays and the surface.

DEM. Let FD and FB represent two diverging rays flowing from the point F as a radiant, which was the imaginary focus of the incident rays in the foregoing case. Then as ED was in that case reflected into DR, FD will be reflected into DK, (for the reason mentioned in Case the second), so that the reflected ray will proceed as from the point R: but it was demonstrated in the case immediately foregoing, that RB is to FB as CR to CF; that is, the distance of the focus from the surface is to that of the radiant from the same, as the distance of the former from the centre is to that of the latter from the same. *Q. E. D.*

CASE 7. Of converging rays falling upon a convex surface, and tending towards a point beyond the centre.

DEM. Let AB, ED, (fig. 8.) be the incident rays tending to F, a point beyond the centre C, and let DK be the reflected ray of the incident one ED. Then because the incident ray ED tends to a point beyond the centre, the reflected ray DK will proceed as from one on the contrary side, suppose R; as explained above under Prop. VII. Through D draw the perpendicular CD, and produce it to H. Then will EDH and HDK be the angles of incidence and reflection; which being equal, their vertical ones CDF and CDR will be so too: consequently the vertex of the triangle FDR is bisected by the line CD: wherefore, RD is to DF, or (3 Elem. 6.) BD vanishing, RB is to BF as RC to CF; that is, the distance of the focus of the reflected rays is to that of the imaginary focus of the incident rays, as the distance of the former from the centre is to the distance of the latter from the same. *Q. E. D.*

CASE 8. Of diverging rays falling upon a concave surface, and proceeding from a point beyond the centre.

DEM. Let FB, FD, be the incident rays having their radiant in F, the imaginary focus of the incident rays in the foregoing case. Then as ED was in that case reflected into DK, FD will now be reflected into DR; so that R will be the focus of the reflected rays. But it was demonstrated in the foregoing case, that RB is to FB as RC to CF; that is, the distance of

the focus of the reflected rays from the surface is to the distance of the radiant from the same, as the distance of the focus of the reflected rays from the centre is to the distance of the radiant from thence. *Q. E. D.*

The two remaining cases may be considered as the converse of those under Prop. II. (p. 5548.), because the incident rays in these are the reflected ones in them; or they may be demonstrated in the same manner with the foregoing, as follows.

CASE 9. Converging rays falling upon a convex surface, and tending to the surface of parallel rays, become parallel after reflection.

DEM. Let ED, RB, (fig. 7.) represent two converging rays incident on the convex surface BD, and tending towards F, which we will now suppose to be the focus of parallel rays; and let DR be the reflected ray, and C the centre of convexity of the reflecting surface. Through C draw the line CD, and produce it to H, drawing RH parallel to ED produced to F. Now it has been demonstrated (Case 5.) where the incident rays are supposed to tend to the point F, that RB is to FB as RC to CF; but F in this Case being supposed to be the focus of parallel rays, it is the middle point between C and B (by proposition 2d), and therefore FB and FC are equal; and consequently the two other terms in the proportion, viz. RB and RC, must be so too; which can only be upon a supposition that R is at an infinite distance from B; that is, that the reflected rays BR and DR be parallel. *Q. E. D.*

CASE 10. Diverging rays falling upon a concave surface, and proceeding from the focus of parallel rays, become parallel after reflection.

DEM. Let RD, RB (fig. 8.) be two diverging rays incident upon the concave surface BD, as supposed in Case 4.; where it was demonstrated that FB is to RB as CF to CR. But in the present case RB and CR are equal, because R is supposed to be the focus of parallel rays; therefore FB and FC are so too. Which cannot be unless F be taken at an infinite distance from B; that is, unless the reflected rays BF and DF be parallel. *Q. E. D.*

Obs. It is here observable, that in the case of diverging rays falling upon a convex surface, (see fig. 7.) the farther the point D is taken from B, the nearer the point F, the focus of the reflected rays, approaches to B, while the radiant R remains the same. For it is evident from the curvature of a circle, that the point D (fig. 9.) may be taken so far from B, that the reflected ray DE shall proceed as from F, G, H, or even from B, or from any point between B and R; and the farther it is taken from B, the farther the point from which it proceeds, approaches towards R: as will easily appear if we draw several incident rays with their respective reflected ones, in such manner that the angles of reflection may be all equal to their respective angles of incidence, as is done in the figure. The like is applicable to any of the other cases of diverging or converging rays incident upon a spherical surface. This is the reason, that when rays are considered as reflected from a spherical surface, the distance of the oblique rays from the perpendicular one is taken so small, that it may be supposed to vanish.

From

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CCXII.

Of  
Reflection.

From hence it follows, that if a number of diverging rays are incident upon the convex surface BD at the several points B, D, D, &c. they shall not proceed after reflection as from any point in the line RB produced, but as from a curve line passing thro' the several points F, f, f, &c. The same is applicable in all the other cases.

Plate  
CCXII.

Had the curvature BD (fig. 7.) been hyperbolic, having its foci in R and F; then R being the radiant, (or the imaginary focus of incident rays), F would have been the focus of the reflected ones, and *vice versa*, however distant the points B and D might be taken from each other. In like manner, had the curve BD (fig. 8.) been elliptical, having its foci in F and R, the one of these being made the radiant (or imaginary focus of incident rays), the other would have been the focus of reflected ones, and *vice versa*. For both in the hyperbola and ellipsis, lines drawn from each of their foci thro' any point make equal angles with the tangent to that point. Therefore, if the incident rays proceed to or from one of their foci, the reflected ones will all proceed as from or to the other. So that, in order that diverging or converging rays may be accurately reflected to or from a point, the reflecting surface must be formed by the revolution of an hyperbola about its longer axis, when the incident rays are such, that their radiant, or imaginary focus of incident rays, shall fall on one side the surface, and the focus of the reflected ones on the other: when they are both to fall on the same side, it must be formed by the revolution of an ellipsis about its longer axis. However, upon account of the great facility with which spherical surfaces are formed in comparison of that with which surfaces formed by the revolution of any of the conic sections about their axes are made, the latter are very rarely used. Add to this another inconvenience, *viz.* that the foci of these curves being mathematical points, it is but one point of the surface of an object that can be placed in any of them at a time, so that it is only in theory that surfaces formed by the revolution of these curves about their axes render reflection perfect.

Now, because the focal distance of rays reflected from a spherical surface cannot be found by the analogy laid down in the third proposition, without making use of the quantity sought; we shall here give an instance whereby the method of doing it in all others will readily appear.

**Prob.** Let it be required to find the focal distance of diverging rays incident upon a convex surface, whose radius of convexity is 5 parts, and the distance of the radiant from the surface is 20.

**Sol.** Call the focal distance sought  $x$ ; then will the distance of the focus from the centre be  $5-x$ , and that of the radiant from the same 25: therefore by prop. 3. we have the following proportion, *viz.*  $x : 20 :: 5-x : 25$ ; and multiplying extremes together and means together, we have  $25x = 100 - 20x$ , which, after due reduction, gives  $x = \frac{100}{45}$ .

If in any case it should happen that the value of  $x$  should be a negative quantity, the focal point must then be taken on the contrary side the surface to that on which it was supposed that it would fall in stating the problem.

If letters instead of figures had been made use of in the foregoing solution, a general theorem might have

been raised, to have determined the focal distance of reflected rays in all cases whatever. See this done in Suppl. to *Gregory's Optics*, 2d edit. p. 112.

Of  
Reflection.

Because it was, in the preceding section, observed, that different incident rays, though tending to or from one point, would after refraction proceed to or from different points, a method was there invented of determining the distinct point, which each separate ray entering a spherical surface converges to, or diverges from, after refraction: the same has been observed here with regard to rays reflected from a spherical surface, (see obs. in case 2. and case 10.) But the method of determining the distinct point to or from which any given incident ray proceeds after reflection, is much more simple. It is only necessary to draw the reflected ray such, that the angle of reflection may be equal to the angle of incidence, which will determine the point it proceeds to or from in any case whatever.

### § 3. Of the Appearance of Bodies Seen by Light reflected from plane and spherical Surfaces.

WHATEVER hath been said concerning the appearance of bodies seen by refracted light through lenses, respects also the appearance of bodies seen by reflection. But besides these, there is one thing peculiar to images by reflection, *viz.* that each point in the representation of an object made by reflection appears situated somewhere in an infinite right line that passes through its correspondent point in the object, and is perpendicular to the reflecting surface.

The truth of this appears sufficiently from the propositions formerly laid down; in each of which, rays flowing from any radiant point, are shewn to proceed, after reflection, to or from some point in a line that passes through the said radiant, and is perpendicular to the reflecting surface. For instance, (fig. 1.) rays flowing from Y are collected in X, a point in the perpendicular CD, which, being produced, passes through Y; again, (fig. 2.) rays flowing from G, proceed, after reflection, as from N, a point in the perpendicular CD, which, being produced, passes thro' G; and so of the rest.

This observation, however, except where an object is seen by reflection from a plain surface, relates only to those cases where the representation is made by means of such rays as fall upon the reflecting surface with a very small degree of obliquity; because such as fall at a considerable distance from the perpendicular, proceed not after reflection as from any point in that perpendicular, but as from other points situated in a certain curve, as hath already been explained; upon which account these rays are neglected, as making a confused and deformed representation. And therefore it is to be remembered, that however the situation of the eye with respect to the object and reflecting surface may be represented in the following figures, it is to be supposed as situated in such a manner with respect to the object, that rays flowing from thence and entering it after reflection, may be such only as fall with a very small degree of obliquity upon the surface; that is, the eye must be supposed to be placed almost directly behind the object, or between it and the reflecting surface. The reason why it is not always so placed, is only to avoid confusion in the figures.

I. When an object is seen by reflection from a plane surface, the image of it appears at the same distance behind the surface that the object is placed before it, of the same magnitude therewith, and directly opposite to it.

To explain this, let AB (fig. 10.) represent an object seen by reflection from the plain surface SV; and let the rays AF, AG, be so inclined to the surface, that they shall enter an eye at H after reflection; and let AE be perpendicular to the surface: then, by the observation just mentioned, the point A will appear in some part of the line AE produced; suppose I, that is, the oblique rays AF and AG will proceed after reflection as from that point; and further, because the reflected rays FH, GK, will have the same degree of inclination to one another that their incident ones have, that point must necessarily be at the same distance from the surface that the point A is; the representation therefore of the point A, will be at the same distance behind the surface that the point itself is before it, and directly opposite to it: consequently, since the like may be shewn of the point B, or of any other, the whole image IM will appear at the same distance behind the surface that the object is before it, and directly opposite to it; and because the lines AI, BM, which are perpendicular to the plain surface, are for that reason parallel to each other, it will also be of the same magnitude therewith.

II. When an object is seen by reflection from a convex surface, its image appears nearer to the surface, and less than the object.

Let AB (fig. 12.) represent the object, SV a reflecting surface whose centre of convexity is C: and let the rays AF, AG, be so inclined to the surface, that after reflection thereat they shall enter the eye at H; and let AE be perpendicular to the surface: then will the oblique rays AF, AG, proceed after reflection as from some point in the line AE produced, suppose from I; which point, because the reflected rays will diverge more than the incident ones, must be nearer to the surface than the point A. And since the same is also true of the rays which flow from B, or any other point, the representation IM will be nearer to the surface than the object; and because it is terminated by the perpendiculars AE and BF which incline to each other, as concurring at the centre, it will also appear less.

III. When an object is seen by reflection from a concave surface, the representation of it is various, both with regard to its magnitude and situation, according as the distance of the object from the reflecting surface is greater or less.

1. When the object is nearer to the surface than its focus of parallel rays, the image falls on the opposite side of the surface, is more distant from it, and larger than the object.

Thus, let AB (fig. 13.) be the object, SV the reflecting surface, F the focus of parallel rays, and C its centre. Through A and B, the extremities of the object, draw the line CE, CR, which will be perpendicular to the surface; and let the rays AR, AG, be incident upon such points of it that they shall be reflected into an eye at H. Now, because the radiant points A and B are nearer the surface than F the focus of parallel rays, the reflected rays will di-

verge, and will therefore proceed as from some points on the opposite side the surface; which points, by the observation laid down at the beginning of this section, will be in the perpendiculars AE, BR, produced, suppose in I and M: but they will diverge in a less degree than their incident ones (see the proposition just referred to), and therefore the said points will be farther from the surface than the points A and B. The image therefore will be on the opposite side of the surface with respect to the object; it will be more distant than it; and consequently, being terminated by the perpendiculars CI and CM, it will also be larger.

2. When the object is placed in the focus of parallel rays, the reflected rays enter the eye parallel, in which case the image ought to appear at an infinite distance behind the reflecting surface; but the representation of it, for the like reasons that were given in the foregoing case, being large and distant, we judge it not much farther from the surface than the image.

3. When the object is placed between the focus of parallel rays and the centre, the image falls on the opposite side the centre, is larger than the object, and in an inverted position.

Thus let AB (fig. 14.) represent the object, SV the reflecting surface, F its focus of parallel rays, and C its centre. Through A and B, the extremities of the object, draw the lines CE and CN, which will be perpendicular to the surface; and let AR, AG, be a pencil of rays flowing from A. These rays proceeding from a point beyond the focus of parallel rays will after reflection converge towards some point on the opposite side the centre, which will fall upon the perpendicular EC produced, but at a greater distance from C than the radiant A from which they diverged. For the same reason, rays flowing from B will converge to a point in the perpendicular NC produced, which shall be farther from C than the point B; from whence it is evident, that the image IM is larger than the object AB, that it falls on the contrary side the centre, and that their positions are inverted with respect to each other.

4. If the object be placed beyond the centre of convexity, the image is then formed between the centre, and the focus of parallel rays is less than the object, and its position is inverted.

The proposition is the converse of the foregoing: for as in that case rays proceeding from A were reflected to I, and from B to M; so rays flowing from I and M will be reflected to A and B; if therefore an object be supposed to be situated beyond the centre in IM, the image of it will be formed in AB between that and the focus of parallel rays, will be less than the object, and inverted.

5. If the middle of the object be placed in the centre of convexity of the reflecting surface, the object and its image will be coincident; but the image will be inverted with respect to the object.

That the place of the image and the object should be the same in this case needs little explication; for the middle of the object being in the centre, rays flowing from thence will fall perpendicularly upon the surface, and therefore necessarily return thither again; so that the middle of the image will be coincident with the

Of  
Reflection.

the middle of the object. But that the image should be inverted is perhaps not so clear. To explain this, let AB (fig. 15.) be the object, having its middle point C in the centre of the reflecting surface SV; through the centre and the point R draw the line CR, which will be perpendicular to the reflecting surface; join the points AR and BR, and let AR represent a ray flowing from A; this will be reflected into RB: for C being the middle point between A and B, the angles ARC and CRB are equal; and a ray from B will likewise be reflected to A; and therefore the position of the image will be inverted with respect to that of the object.

In this proposition it is to be supposed that the object AB is so situated with respect to the reflecting surface, that the angle ACR may be right; for otherwise the angles ARC and BRC will not be equal, and part of the image will therefore fall upon the object and part off.

6. If in any of the three last cases, in each of which the image is formed on the same side the reflecting surface with the object, the eye be situated farther from the surface than the place where the image falls, the rays of each pencil, crossing each other in the several points of the image, will enter the eye as from a real object situated there; so that the image will appear pendulous in the air between the eye and the reflecting surface, and in the position wherein it is formed, viz. inverted with respect to the object in the same manner that an image formed by refracted light appears to an eye placed beyond it; which was fully explained under Prop. IV. (p. 554.) and therefore needs not be repeated here.

But as to what relates to the appearance of the object when the eye is placed nearer to the surface than the image, that was not there fully inquired into. That point shall therefore now be more strictly examined under the following case, which equally relates to refracted and reflected light.

7. If the eye be situated between the reflecting surface and the place of the image, the object is then seen beyond the surface; and the farther the eye recedes from the surface towards the place of the image, the more confused, larger, and nearer the object appears.

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To explain this, let AB (fig. 16.) represent the object; IM its image, one of whose points M is formed by the concurrence of the reflected rays DM, EM, &c. which before reflection came from B; the other, I, by the concurrence of DI, EI, &c. which came from A: and let  $ab$  be the pupil of an eye, situated between the surface DP and the image. This pupil will admit the rays  $Ha$ ,  $Kb$ ; which, because they are tending towards I, are such as came from A, and therefore the point A will appear diffused over the space RS. In like manner the pupil will also receive into it the reflected rays  $Ka$  and  $Lb$ , which, because they are tending towards M, by supposition came from B; and therefore the point B will be seen spread as it were over the space TV, and the object will seem to fill the space RV; but the representation of it will be confused, because the intermediate points of the object being equally enlarged in appearance, there will not be room for them between the points S and T, but they will coincide in part one with another: for

instance, the appearance of that point in the object, whose representation falls upon  $e$  in the image, will fill the space  $mn$ ; and so of the rest. Now if the same pupil be removed into the situation  $ef$ , the reflected rays  $Ee$  and  $Gf$  will then enter the eye, and therefore one extremity of the object will appear to cover the space XY; and because the rays  $Of$  and  $Le$  will also enter it in their progress towards M, the point B, from whence they came, will appear to cover ZV; the object therefore will appear larger and more confused than before. And when the eye recedes quite to the image, it sees but one single point of the object, and that appears diffused all over the reflecting surface; for instance, if the eye recedes to the point M, then rays flowing from the point B enter it upon whatever part of the surface they fall; and so for the rest. The object also appears nearer to the surface, the farther the eye recedes from it towards the place of the image; probably because, as the appearance of the object becomes more and more confused, its place is not so easily distinguished from that of the reflecting surface itself, till at last when it is quite confused (as it is when the eye is arrived at M) they both appear as one, the surface assuming the colour of the object.

As to the precise apparent magnitude of an object seen after this manner, it is such that the angle it appears under shall be equal to that which the image of the same object would appear under were we to suppose it seen from the same place: that is, the apparent object (for such we must call it to distinguish it from the image of the same object) and the image subtend equal angles at the eye.

DEM. Here we must suppose the pupil of the eye to be a point only, because the magnitude of that causes small alteration in the apparent magnitude of the object; as we shall see by and by. Let then the point  $a$  represent the pupil, then will the extreme rays that can enter it be  $Ha$  and  $Ka$ ; the object therefore will appear under the angle  $H a K$ , which is equal to its vertical one  $M a I$ , under which the image IM would appear were it to be seen from  $a$ . Again, if the eye be placed in  $f$ , the object appears under the angle  $G f O$  equal to  $I f M$ , which the image subtends at the same place, and therefore the apparent object and image of it subtend equal angles at the eye. Q. E. D.

Now if we suppose the pupil to have any sensible magnitude, such, suppose, that its diameter may be  $ab$ ; then the object seen by the eye in that situation will appear under the angle  $H x L$ , which is larger than the angle  $H a K$ , under which it appeared before; because the angle at  $x$  is nearer than the angle at  $a$ , to the line IM, which is a subtense common to them both.

From this proposition it follows, that, were the eye close to the surface at K, the real and apparent object would be seen under equal angles (for the real object appears from that place under the same angle that the image does, as will be shewn at the end of this section): therefore, when the eye is nearer to the image than that point, the image will subtend a larger angle at it than the object does; and consequently, since the image and apparent object subtend equal angles at the eye, the apparent object must necessarily be seen under a larger angle than the object itself, where-

wherever the eye be placed, between the surface and the image.

As each point in the representation of an object made by reflection is situated somewhere in a right line that passes through its correspondent point in the object, and is perpendicular to the reflecting surface, as was shewn in the beginning of this section; we may from hence deduce a most easy and expeditious method of determining both the magnitude and situation of the image in all cases whatever. Thus,

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CCXII.

Through the extremities of the object AB and the centre C, (fig. 17, 18, or 19.) draw the lines AC BC, and produce them as the case requires; these lines will be perpendicular to the reflecting surface, and therefore the extremities of the image will fall upon them. Through F the middle point of the object and the centre, draw the line FC, and produce it till it passes through the reflecting surface; this will also be perpendicular to the surface. Through G, the point where this line cuts the surface, draw the lines AG and BG, and produce them this way or that, till they cross the former perpendiculars; and where they cross, there I and M the extremities of the image will fall. For supposing AG to be a ray proceeding from the point A and falling upon G, it will be reflected to B; because FA is equal to FB, and FG is perpendicular to the reflecting surface; and therefore the representation of the point A will be in BG produced as well as in AC; consequently it will fall on the point I, where they cross each other. Likewise the ray BG will for the same reason be reflected to A; and therefore the representation of the point B will be in AG produced as well as in some part of BC, that is, in M where they cross. From whence the proposition is clear.

If it happens that the lines will not cross which way soever they are produced, as in fig. 20. then is the object in the focus of parallel rays of that surface, and has no image formed in any place whatever. For in this case the rays AH, AG, flowing from the point A, become parallel after reflection in the lines HC, GB, and therefore do not flow as to or from any point: in like manner, rays flowing from B are reflected into the parallel lines KB and GA; so that no representation can be formed by such reflection.

From hence we learn another circumstance relating to the magnitude of the image made by reflection; viz. that it subtends the same angle at the vertex of the reflecting surface that the object does. This appears by inspection of the 17th, 18th, or 19th figure, in each of which the angle IGM, which the image subtends at G the vertex of the reflecting surface, is equal to the angle AGB, which the object subtends at the same place; for in the two first of those figures they are vertical, in the third they are the same. And,

Farther, the angle ICM, which the image subtends at the centre, is also equal to the angle ACB which the object subtends at the same place; for in the two first figures they are the same, in the last they are vertical to each other.

From whence it is evident, that the object and its image are to each other in diameter, either as their respective distances from the vertex of the reflecting surface, or as their distances from the centre of the same.

IV. As objects are multiplied by being seen thro' transparent media, whose surfaces are properly disposed, so they may also by reflecting surfaces. Thus,

Differ  
Refrang  
bility of  
Light.

1. If two reflecting surfaces be disposed at right angles, as the surfaces AB, BC, (fig. 21.), an object at D may be seen by an eye at E, after one reflection at F, in the line EF produced; after two reflections, the first at G, the second at H, in the line EH produced; and also, after one reflection made at A, in the line EA produced.

2. If the surfaces be parallel, as AB, CD, (fig. 22.), and the object be placed at E and the eye at F, the object will appear multiplied an infinite number of times: thus, it may be seen in the line FG produced, after one reflection at G; in the line FH produced, after two reflections, the first at I, the second at H; and also in FP produced, after several successive reflections of the ray EL, at the points L, M, N, O, and P: and so on *in infinitum*. But the greater the number of reflections are, the weaker the representation will be.

#### SECT. IV. Of the different Refrangibility of Light.

As this property of light solves a great number of the phenomena which could not be understood by former opticians, we shall give an account of it in the words of Sir Isaac Newton, who first discovered it; especially as his account is much more full, clear, and perspicuous, than those of succeeding writers.

“ In a very dark chamber, at a round hole F, about one third of an inch broad, made in the shut of a window, I placed a glass prism ABC, whereby the beam of the sun's light, SF, which came in at that hole, might be refracted upwards, toward the opposite wall of the chamber, and there form a coloured image of the sun, represented at PT. The axis of the prism, (that is, the line passing thro' the middle of the prism, from one end of it to the other end, parallel to the edge of the refracting angle) was in this and the following experiments perpendicular to the incident rays. About this axis I turned the prism slowly, and saw the refracted light on the wall, or coloured image of the sun, first to descend, and then to ascend. Between the descent and ascent when the image seemed stationary, I stopped the prism and fixed it in that posture.

“ Then I let the refracted light fall perpendicularly upon a sheet of white paper, MN, placed at the opposite wall of the chamber, and observed the figure and dimensions of the solar image, PT, formed on the paper by that light. This image was oblong and not oval, but terminated by two rectilinear and parallel sides and two semicircular ends. On its sides it was bounded pretty distinctly; but on its ends very confusedly and indistinctly, the light there decaying and vanishing by degrees. At the distance of  $18\frac{1}{2}$  feet from the prism the breadth of the image was about  $2\frac{1}{2}$  inches, but its length was about  $10\frac{1}{2}$  inches, and the length of its rectilinear sides about eight inches; and ACB, the refracting angle of the prism, whereby so great a length was made, was 64 degrees. With a less angle the length of the image was less, the breadth remaining the same. It is farther to be observed, that the rays went on in straight lines from the prism to the image, and

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fig. 9.

and



Fig. 1.

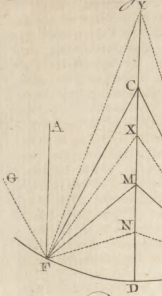


Fig. 2.

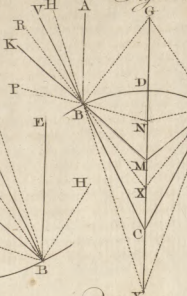


Fig. 3.

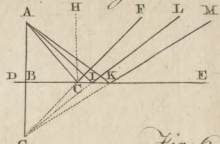


Fig. 4.

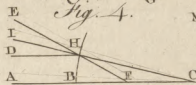


Fig. 6.

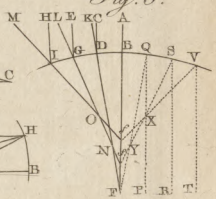


Fig. 5.

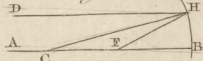


Fig. 7.

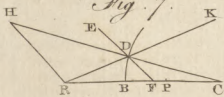


Fig. 9.

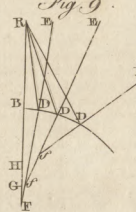


Fig. 10.

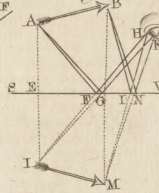


Fig. 11.

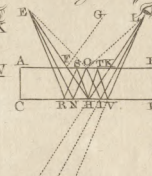


Fig. 19.

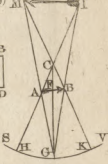


Fig. 8.

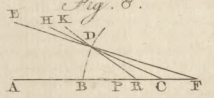


Fig. 16.

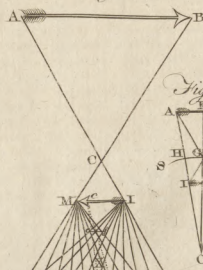


Fig. 18.



Fig. 20.



Fig. 12.

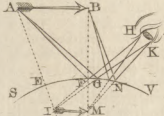


Fig. 14.

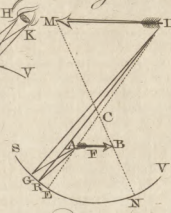


Fig. 13.

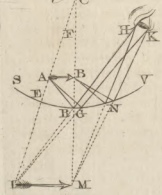


Fig. 15.

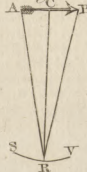


Fig. 17.



Fig. 21.

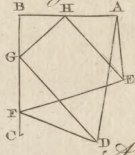
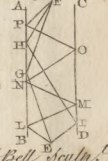
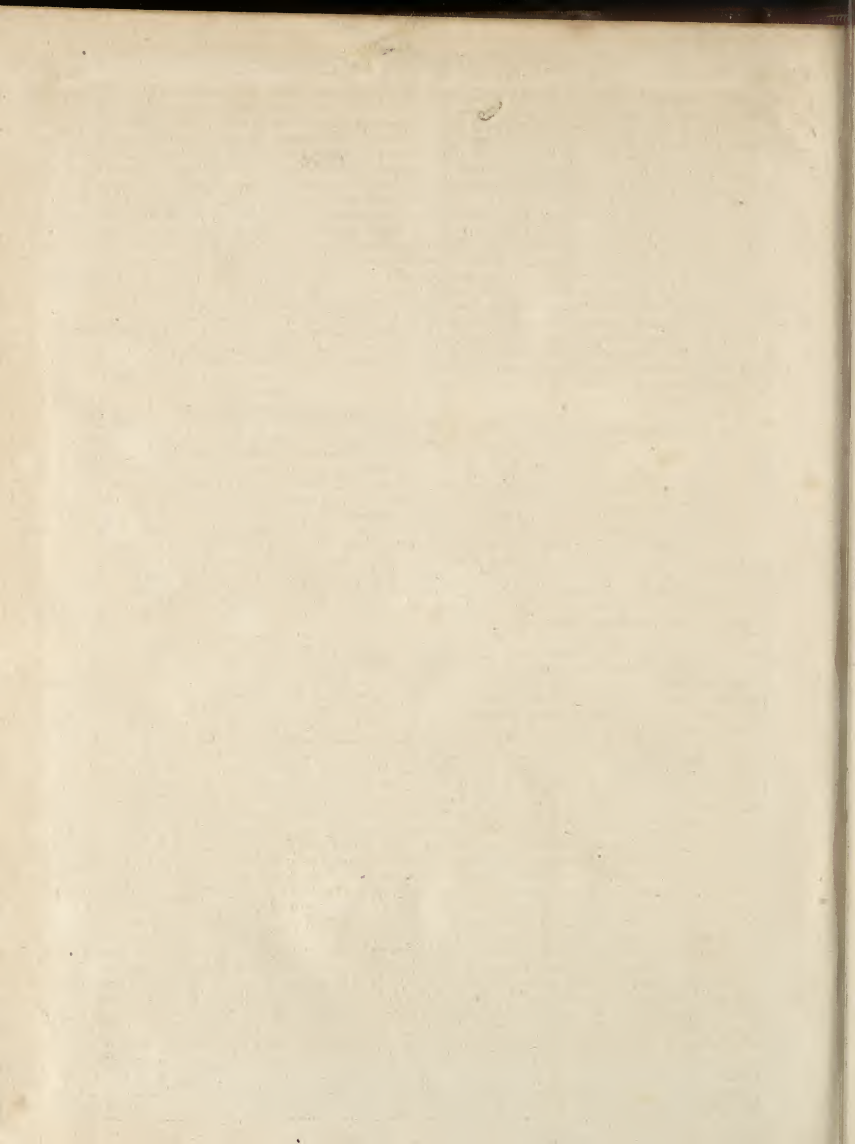


Fig. 22.



A Bell Sculpt.



Different  
Refrangibility of  
Light.

and therefore at their going out of the prism had all that inclination to one another from which the length of the image proceeded. This image  $PT$  was coloured, and the more eminent colours lay in this order from the bottom at  $T$  to the top at  $P$ ; red, orange, yellow, green, blue, indigo, violet; together with all their intermediate degrees in a continual succession perpetually varying."

Our author concludes from this experiment, and many more to be mentioned hereafter, "that the light of the sun consists of a mixture of several sorts of coloured rays, some of which at equal incidences are more refracted than others, and therefore are called *more refrangible*. The red at  $T$ , being nearest to the place  $Y$ , where the rays of the sun would go directly if the prism was taken away, is the least refracted of all the rays; and the orange, yellow, green, blue, indigo, and violet, are continually more and more refracted, as they are more and more diverted from the course of the direct light. For by mathematical reasoning he has proved, that when the prism is fixed in the posture above-mentioned, so that the place of the image shall be the lowest possible, or at the limit between its descent and ascent, the figure of the image ought then to be round like the spot at  $Y$ , if all the rays that tended to it were equally refracted. Therefore, seeing by experience it is found that this image is not round, but about five times longer than broad, it follows that all the rays are not equally refracted. And this conclusion is farther confirmed by the following experiments.

"In the sun-beam  $SF$ , which was propagated into the room thro' the hole in the window-shut  $EG$ , at the distance of some feet from the hole, I held the prism  $ABC$  in such a posture, that its axis might be perpendicular to that beam: then I looked thro' the prism upon the hole  $F$ , and turning the prism to and fro about its axis to make the image  $pt$  of the hole ascend and descend, when between its two contrary motions it seemed stationary, I stopped the prism; in this situation of the prism, viewing through it the said hole  $F$ , I observed the length of its refracted image  $pt$  to be many times greater than its breadth; and that the most refracted part thereof appeared violet at  $p$ ; the least refracted red, at  $t$ ; and the middle parts indigo, blue, green, yellow, and orange, in order. The same thing happened when I removed the prism out of the sun's light, and looked through it upon the hole shining by the light of the clouds beyond it. And yet if the refractions of all the rays were equal according to one certain proportion of the sines of incidence and refraction, as is vulgarly supposed, the refracted image ought to have appeared round, by the mathematical demonstration above-mentioned. So then by these two experiments it appears, that in equal incidences there is a considerable inequality of refractions."

For the discovery of this fundamental property of light, which has opened the whole mystery of colours, we see our author was not only beholden to the experiments themselves, which many others had made before him, but also to his skill in geometry; which was absolutely necessary to determine what the figure of the refracted image ought to be upon the old principle of an equal refraction of all the rays: but having thus made the discovery, he contrived the follow-

ing experiment to prove it at sight.

"In the middle of two thin boards,  $DE$ ,  $de$ , I made a round hole in each, at  $G$  and  $g$ , a third part of an inch in diameter; and in the window-shut a much larger hole being made, at  $F$ , to let into my darkened chamber a large beam of the sun's light, I placed a prism,  $ABC$ , behind the shut in that beam, to refract it towards the opposite wall; and close behind this prism I fixed one of the boards  $DE$ , in such a manner that the middle of the refracted light might pass through the hole made in it at  $G$ , and the rest be intercepted by the board. Then at the distance of about 12 feet from the first board, I fixed the other board,  $de$ , in such manner that the middle of the refracted light, which came through the hole in the first board, and fell upon the opposite wall, might pass through the hole  $g$  in this other board  $de$ , and the rest being intercepted by the board, might pass upon it the coloured spectrum of the sun. And close behind this board I fixed another prism  $abc$ , to refract the light which came through the hole  $g$ . Then I retraced speedily to the first prism  $ABC$ , and by turning it slowly to and fro about its axis, I caused the image which fell upon the second board  $de$ , to move up and down upon that board, that all its parts might pass successively through the hole in that board, and fall upon the prism behind it. And in the mean time I noted the places,  $M$ ,  $N$ , on the opposite wall, to which that light after its refraction in the second prism did pass; and by the difference of the places at  $M$  and  $N$ , I found that the light, which being most refracted in the first prism  $ABC$ , did go to the blue end of the image, was again more refracted by the second prism  $abc$ , than the light which went to the red end of that image. For when the lower part of the light which fell upon the second board  $de$ , was cast through the hole  $g$ , it went to a lower place  $M$  on the wall; and when the higher part of that light was cast through the same hole  $g$ , it went to a higher place,  $N$ , on the wall; and when any intermediate part of the light was cast through that hole, it went to some place in the wall between  $M$  and  $N$ . The unchanged position of the holes in the boards made the incidence of the rays upon the second prism to be the same in all cases. And yet in that common incidence some of the rays were more refracted and others less: and those were more refracted in this prism, which by a greater refraction in the first prism were more turned out of their way; and therefore, for their constancy of being more refracted, are deservedly called *more refrangible*."

Our author shews also, by experiments made with a convex glass, that lights (reflected from natural bodies) which differ in colour, differ also in degrees of refrangibility: and that they differ in the same manner as the rays of the sun do.

"The sun's light consists of rays differing in reflexivity, and those rays are more reflexible than others which are more refrangible. A prism,  $ABC$ , whose two angles, at its base  $BC$ , were equal to one another and half right ones, and the third at  $A$  a right one, I placed in a beam  $FM$  of the sun's light, let into a dark chamber through a hole  $F$  one third part of an inch broad. And turning the prism slowly about its axis until the light which went through one of its angles

Different  
Refrangibility of  
Light.

Plate  
CCXI.  
fig. 11.

Plate  
CCXI.  
fig. 10.

Fig. 12.

angles ACB, and was refracted by it to G and H, began to be reflected into the line MN by its base BC, at which till then it went out of the glass; I observed that those rays, as MH, which had suffered the greatest refraction, were sooner reflected than the rest. To make it evident that the rays which vanished at H were reflected into the beam MN, I made this beam pass thro' another prism VXY, and being refracted by it to fall afterwards upon a sheet of white paper *pt* placed at some distance behind it, and there by that refraction to paint the usual colours at *pt*. Then causing the first prism to be turned about its axis according to the order of the letters ABC, I observed, that when those rays MH, which in this prism had suffered the greatest refraction, and appeared blue and violet, began to be totally reflected, the blue and violet light on the paper which was most refracted in the second prism received a sensible increase at *p*, above that of the red and yellow at *t*: and afterwards, when the rest of the light, which was green, yellow, and red, began to be totally reflected and vanished at G, the light of those colours at *t*, on the paper *pt*, received as great an increase as the violet and blue had received before. Which puts it past dispute, that those rays became first of all totally reflected at the base BC, which before at equal incidences with the rest upon the base BC had suffered the greatest refraction. I do not here take notice of any refractions made in the sides AC, AB, of the first prism, because the light enters almost perpendicularly at the first side, and goes out almost perpendicularly at the second; and therefore suffers none, or so little, that the angles of incidence at the base BC are not sensibly altered by it; especially if the angles of the prism at the base BC be each about 40 degrees. For the rays FM begin to be totally reflected when the angle CMF is about 50 degrees, and therefore they will then make a right angle of 90 degrees with AC.

“ It appears also from experiments, that the beam of light MN, reflected by the base of the prism, being augmented first by the more refrangible rays and afterwards by the less refrangible, is composed of rays differently refrangible.

“ The light whose rays are all alike refrangible, I call *simple homogeneous and similar*; and that whose rays are some more refrangible than others, I call *compound heterogeneous and dissimilar*. The former light I call *homogeneous*, not because I would affirm it so in all respects; but because the rays which agree in refrangibility agree at least in all their other properties which I consider in the following discourse.

“ The colours of homogeneous lights I call *primary, homogeneous and simple*; and those of heterogeneous lights, *heterogeneous and compound*. For these are always compounded of homogeneous lights, as will appear in the following discourse.

“ The homogeneous light and rays which appear red, or rather make objects appear so, I call *rubrific or red making*; those which make objects appear yellow, green, blue, and violet, I call *yellow-making, green-making, blue-making, violet-making*; and so the rest. And if at any time I speak of light and rays as coloured or endowed with colours, I would be understood to speak not philosophically and properly, but grossly, and according to such conceptions as vulgar people in seeing all these experiments would be apt to

frame. For the rays, to speak properly, are not coloured. In them there is nothing else than a certain power and disposition to stir up a sensation of this or that colour. For as found in a bell or musical string or other sounding body, is nothing but a trembling motion, and in the air nothing but that motion propagated from the object, and in the sensorium it is a sense of that motion under the form of sound; so colours in the object are nothing but a disposition to reflect this or that sort of rays more copiously than the rest: in rays they are nothing but their dispositions to propagate this or that motion into the sensorium; and in the sensorium they are sensations of those motions under the forms of colours.

“ By the mathematical proposition above-mentioned, it is certain that the rays which are equally refrangible do fall upon a circle answering to the sun's apparent disk, which will also be proved by experiment by and by. Now let AG represent the circle <sup>Plate CCXI.</sup> which all the most refrangible rays, propagated from the whole disk of the sun, would illuminate and paint upon the opposite wall if they were alone; EL the circle, which all the least refrangible rays would in like manner illuminate if they were alone; BH, CI, DK, the circles which for many intermediate sorts would paint upon the wall, if they were singly propagated from the sun in successive order, the rest being intercepted; and conceive that there are other circles without number, which innumerable other intermediate sorts of rays would successively paint upon the wall, if the sun should successively emit every sort apart. And seeing the sun emits all these sorts at once, they must all together illuminate and paint innumerable equal circles; of all which, being according to their degrees of refrangibility placed in order in a continual series, that oblong spectrum PT is composed, which was described in the first experiment.

“ Now if these circles, whilst their centres keep their distances and positions, could be made less in diameter, their interfering one with another, and consequently the mixture of the heterogeneous rays, would be proportionably diminished. Let the circles AG, BH, CI, &c. remain as before; and let *ag, bh, ci, &c.* be so many less circles lying in a like continual series, between two parallel right lines *ae* and *gl*, with the same distances between their centres, and illuminated with the same sorts of rays: that is, the circle *ag* with the same fort by which the corresponding circle AG was illuminated; and the rest of the circles *bh, ci, dk, el* respectively with the same forts of rays by which the corresponding circles BH, CI, DK, EL, were illuminated. In the figure PT composed of the great circles, three of those, AG, BH, CI, are so expanded into each other, that three sorts of rays, by which those circles are illuminated, together with innumerable other sorts of intermediate rays, are mixed at QR in the middle of the circle BH. And the like mixture happens throughout almost the whole length of the figure PT. But in the figure *pt*, composed of the less circles, the three less circles *ag, bh, ci*, which answer to those three greater, do not extend into one another; nor are there any where mingled so much as any two of the three sorts of rays by which those circles are illuminated, and which in the figure PT are all of them intermingled at QR. So then, if we would diminish the mixture

Different  
Refrangi-  
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Different  
Refrangi-  
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Light.

mixture of the rays, we are to diminish the diameters of the circles. Now these would be diminished if the sun's diameter, to which they answer, could be made less than it is, or (which comes to the same purpose) if without doors, at a great distance from the prism towards the sun, some opaque body were placed with a round hole in the middle of it to intercept all the sun's light, except so much as coming from the middle of his body could pass through that hole to the prism. For so the circles *AG*, *BH*, and the rest, would not any longer answer to the whole disk of the sun, but only to that part of it which could be seen from the prism through that hole; that is, to the apparent magnitude of that hole viewed from the prism. But that these circles may answer more distinctly to that hole, a lens is to be placed by the prism to cast the image of the hole (that is, every one of the circles *AG*, *BH*, &c.) distinctly upon the paper at *PT*; after such a manner, as by a lens placed at a window the pictures of objects abroad are cast distinctly upon a paper within the room. If this be done, it will not be necessary to place that hole very far off, no not beyond the window. And therefore, instead of that hole, I used the hole in the window-shut as follows.

"In the sun's light let into my darkened chamber through a small round hole in my window-shut, at about 10 or 12 feet from the window, I placed a lens *MN*, by which the image of the hole *F* might be distinctly cast upon a sheet of white paper placed at *I*. Then immediately after the lens I placed a prism *ABC*, by which the trajected light might be refracted either upwards or sideways, and thereby the round image which the lens alone did cast upon the paper at *I*, might be drawn out into a long one with parallel sides, as represented at *pt*. This oblong image I let fall upon another paper at about the same distance from the prism as the image at *I*, moving the paper either towards the prism or from it, until I found the just distance where the rectilinear sides of the image *pt* become most distinct. For in this case the circular images of the hole, which compose that image, after the manner that the circles *ag*, *bb*, *ci*, &c. do the figure *pt*, were terminated most distinctly, and therefore extended into one another the least that they could, and by consequence the mixture of the heterogeneous rays was now the least of all. The circles *ag*, *bb*, *ci*, &c. which compose the image *pt*, are each equal to the circle at *I*; and therefore, by diminishing the hole *F*, or by removing the lens farther from it, may be diminished at pleasure, whilst their centres keep the same distances from each other. Thus, by diminishing the breadth of the image *pt*, the circles of heterogeneous rays that compose it may be separated from each other as much as you please. Yet instead of the circular hole *F*, it is better to substitute an oblong hole shaped like a parallelogram with its length parallel to the length of the prism. For if this hole be an inch or two long, and but a 10th or 20th part of an inch broad, or narrower, the light of the image *pt* will be as simple as before, or simpler; and the image being much broader, is therefore fitter to have experiments tried in its light than before.

"Homogeneous light is refracted regularly without any dilatation, splitting, or shattering of the rays; and the confused vision of objects seen through refracting

bodies by heterogeneous light, arises from the different refrangibility of several sorts of rays. This will appear by the experiments which will follow. In the middle of a black paper I made a round hole about a fifth or a sixth part of an inch in diameter. Upon this paper I caused the spectrum of homogeneous light, described in the former article, to fall that some part of the light might pass through the hole in the paper. This transmitted part of the light I refracted with a prism placed behind the paper; and, letting this refracted light fall perpendicularly upon a white paper, two or three feet distant from the prism, I found that the spectrum formed on the paper by this light was not oblong, as when it is made in the first experiment, by refracting the sun's compound light, but was, so far as I could judge by my eye, perfectly circular, the length being nowhere greater than the breadth; which shews that this light is refracted regularly without any dilatation of the rays, and is an ocular demonstration of the mathematical proposition mentioned above.

"In the homogeneous light I placed a paper circle of a quarter of an inch in diameter; and in the sun's unrefracted, heterogeneous, white light, I placed another paper circle of the same bigness; and going from these papers to the distance of some feet, I viewed both circles through a prism. The circle illuminated by the sun's heterogeneous light appeared very oblong, as in the second experiment, the length being many times greater than the breadth. But the other circle illuminated with homogeneous light appeared circular, and distinctly defined, as when it is viewed by the naked eye; which proves the whole proposition mentioned in the beginning of this article.

"In the homogeneous light I placed flies and such like minute objects, and viewing them through a prism I saw their parts as distinctly defined as if I had viewed them with the naked eye. The same objects placed in the sun's unrefracted heterogeneous light, which was white, I viewed also through a prism, and saw them most confusedly defined, so that I could not distinguish their smaller parts from one another. I placed also the letters of a small print one while in the homogeneous light, and then in the heterogeneous; and viewing them through a prism, they appeared in the latter case so confused and indistinct that I could not read them; but in the former, they appeared so distinct that I could read readily, and thought I saw them as distinct as when I viewed them with my naked eye; in both cases, I viewed the same objects through the same prism, at the same distance from me, and in the same situation. There was no difference but in the lights by which the objects were illuminated, and which in one case was simple, in the other compound; and therefore the distinct vision in the former case, and confused in the latter, could arise from nothing else than from that difference in the lights. Which proves the whole proposition.

"In these three experiments, it is farther very remarkable, that the colour of homogeneous light was never changed by the refraction. And as these colours were not changed by refractions, so neither were they by reflections. For all white, grey, red, yellow, green, blue, violet bodies, as paper, silks, red lead, orpiment, indigo, bice, gold, silver, copper, grass, blue flowers, violets, bubbles of water tinged with various colours,

colours, peacocks feathers, the tincture of lignum nephriticum, and such like, in red homogeneal light appeared totally red, in blue light totally blue, in green light totally green, and so of other colours. In the homogeneal light of any colour they all appeared totally of that same colour; with this only difference, that some of them reflected that light more strongly, others more faintly. I never yet found any body which by reflecting homogeneal light could sensibly change its colour.

“ From all which it is manifest, that if the sun's light consisted of but one sort of rays, there would be but one colour in the world, nor would it be possible to produce any new colour by reflections and refractions, and by consequence, that the variety of colours depends upon the composition of light.

“ The solar image *pt*, formed by the separated rays in the 5th experiment, did in the progress from its end *p*, on which the most refrangible rays fell, unto its end *t*, on which the least refrangible rays fell, appear tinged with this series of colours; violet, indigo, blue, green, yellow, orange, red, together with all their intermediate degrees in a continual successions perpetually varying; so that there appeared as many degrees of colours as there were sorts of rays differing in re-

frangibility. And since these colours could not be changed by refractions nor by reflections, it follows, that all homogeneal light has its proper colour answering to its degree of refrangibility.

“ Every homogeneal ray considered apart is refracted, according to one and the same rule; so that its sine of incidence is to its sine of refraction in a given ratio: that is, every different coloured ray has a different ratio belonging to it. This our author has proved by experiment, and by other experiments has determined by what numbers those given ratios are expressed. For instance, if an heterogeneal white ray of the sun emerges out of glass into air; or, which is the same thing, if rays of all colours be supposed to succeed one another in the same line AC, and AD their common sine of incidence in glass be divided into 50 equal parts, then EF and GH, the sines of refraction into air, of the least and most refrangible rays, will be 77 and 78 such parts respectively. “ And since every colour has several degrees, the sines of refraction of all the degrees of red will have all intermediate degrees of magnitude from 77 to  $77\frac{1}{2}$ , of all the degrees of orange from  $77\frac{1}{2}$  to  $77\frac{2}{3}$ , of yellow from  $77\frac{2}{3}$  to  $77\frac{3}{4}$ , of green from  $77\frac{3}{4}$  to  $77\frac{4}{5}$ , of blue from  $77\frac{4}{5}$  to  $77\frac{4}{5}$ , of indigo from  $77\frac{4}{5}$  to  $77\frac{4}{5}$ , and of violet from  $77\frac{4}{5}$  to 78.

Plate  
CCXI.  
Fig. 15.

## PART III.

## END OF THE SEVENTH VOLUME.

## DIRECTIONS for placing the PLATES in this VOLUME.

Number of Plates.		Page	Number of Plates.		
192, or Plate	CLXXV.	4991	211, or Plate	CXCIV. } To face <i>Musie</i> , p. (21.)	
193	CLXXVI.	4994	212	CXCV. }	
194	CLXXVII.	4996	213	CXCVI.	5316
195	CLXXVIII.	5037	214	CXCVII.	5318
196	CLXXIX.	5038	215	CXCVIII.	5320
197	CLXXX.	5039	216	CXCIX.	5322
198	CLXXXI.	5065	217	CC.	5323
199	CLXXXII.	5231	218	CCI.	5335
200	CLXXXIII.	5253	229	CCII.	5337
201	CLXXXIV.	5254	220	CCIII.	5347
202	CLXXXV.	5262	221	CCIV.	5373
203	CLXXXVI.	} To face <i>Musie</i> , p. (21.)	222	CCV.	5456
204	CLXXXVII.		223	CCVI.	5487
205	CLXXXVIII.		224	CCVII.	5499
206	CLXXXIX.		225	CCVIII.	5512
207	CXC.		226	CCIX.	5528
208	CXCI.	227	CCX.	5538	
209	CXCII.	228	CCXI.	5544	
210	CXCIII.	229	CCXII.	5554	

N. B. ERRATA, OMISSIONS, &c. noticed and supplied in the APPENDIX at the end of the Work.













